BUMPER TO BUMPER: THE NEED FOR A NATIONAL SURFACE TRANSPORTATION RESEARCH AGENDA

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

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C O N T E N T S

July 11, 2019

BUMPER TO BUMPER:
THE NEED FOR A NATIONAL SURFACE TRANSPORTATION RESEARCH AGENDA

THURSDAY, JULY 11, 2019

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to notice, at 3:28 p.m., in room 2318 of the Rayburn House Office Building, Hon. Haley Stevens [Chairwoman of the Subcommittee] presiding.

U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON RESEARCH & TECHNOLOGY
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

HEARING CHARTER

Bumper to Bumper: The Need for a National Surface Transportation Research Agenda

Thursday, July 11, 2019
2:00 p.m. – 4:00 p.m.
2318 Rayburn House Office Building

PURPOSE

On Thursday, July 11, 2019, the Subcommittee on Research and Technology of the Committee on Science, Space, and Technology will hold a hearing titled, "*Bumper to Bumper: The Need for a National Surface Transportation Research Agenda*." The purpose of this hearing is to review the Department of Transportation's surface transportation research, development, and demonstration and technology transfer activities, examine implementation of research provisions of the 2015 *Fixing America's Surface Transportation Act of 2015* ("FAST Act") and explore the need for a long-term national surface transportation research agenda.

WITNESSES

- **Mr. Tim Henkel**, Chair, Research and Technology Coordinating Committee, Transportation Research Board and Assistant Commissioner, Modal Planning and Program Management, Minnesota Department of Transportation
- **Mr. Brian Ness,** Director, Idaho Transportation Department and Chair, American Association of State Highway and Transportation Officials Special Committee on Research and Innovation
- **Dr. Henry Liu**, Director, Center for Connected and Automated Transportation and Professor, Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor
- **Dr. Darcy Bullock,** Director, Joint Transportation Research Program and Lyles Family Professor, Department of Civil Engineering, Purdue University

OVERARCHING QUESTIONS

- How has the Department of Transportation (DOT) implemented the policies and programs mandated in the 2015 FAST Act, specifically as they relate to research, development and technology (RD&T)? What changes or improvements to RD&T programs and policies, if any, should Congress consider for reauthorization of the FAST Act?

- How has DOT coordinated across the modal operating administrations and with research partners in setting priorities and implementing its RD&T programs? How has DOT worked with states to help test and deploy technologies developed through DOT programs?

- How are short-term and applied research needs balanced with long-term research investments required for future innovation?

- Is there a need for a long-term (20+ year) national surface transportation research strategy? How might such a strategy help guide the development of technologies that will address safety, security, congestion, emissions reduction, and other important goals well into the future?

Long Term Research Vison

Today, the U.S. population, at 329 million, is double the population of 1956 when construction of the National Highway System began. With projections of more than 400 million people living in the U.S. by 2050, the current costs of outdated infrastructure – the direct economic costs as well as the costs associated with safety, congestion, and environmental impacts – will continue to worsen if nothing changes. Research has played a key role in the development of today's technology that is helping improve how we move people and commerce. However, there is still much research to be addressed as needs for the built environment change and the impacts of climate change increase across the nation. These vary from more resilient building materials to behavioral studies related to adoption of new transportation technologies. The Department of Transportation does operate under a 5-year research, development, and technology (RD&T) strategic plan[1]. However, a long-term vision for surface transportation research could help guide solutions to existing challenges and ensure adequate planning and connectivity for the future.

Department of Transportation Research

The U.S. Department of Transportation (DOT) oversees 11 operating administrations that cover air, land, and seafaring transportation. The primary offices that carry out significant surface transportation RD&T activities include the Office of the Assistant Secretary for Research and Technology (OST-R), Federal Highway Administration (FHWA), Federal Transit Administration (FTA), National Highway Traffic Safety Administration (NHTSA), Federal Railroad Administration (FRA).

[1] https://www.transportation.gov/sites/dot.gov/files/docs/USDOT-RD%26T-Strategic-Plan-Final-011117.pdf

The Federal-aid Highway Program, public transportation programs and related research are authorized under the surface transportation law (often referred to as the highway bill). The 5-year FAST Act is the most recent surface transportation law. Authorization of major research programs is found under Title VI, the Innovation title. The FAST Act also authorizes transportation of hazardous materials, safety, freight and rail activities. The FAST Act provides about $45 billion per year for highway programs and $12 billion per year for public transportation programs. Just under $700 million of that goes to research programs.

FAST Act programs are funded through allocations from the Highway Trust Fund (HTF) which receives gas tax revenues, and through the appropriations process. The HTF does not receive enough in gas tax receipts to cover all of the program expenditures authorized in the FAST Act. Since 2008, Congress has appropriated almost $144 billion to make up for HTF shortfalls.[2] This appropriation is technically a transfer to the HTF. RD&T programs are funded through both the HTF and annual appropriations.

Office of the Assistant Secretary for Research and Technology (OST-R)

The Office of the Assistant Secretary for Research and Technology (OST-R) is under the Office of the Secretary of Transportation. OST-R is responsible for research coordination, technology transfer, and statistics activities across the department. OST-R receives annual appropriations and was funded at $8.5 million in FY19.

OST-R oversees six major program components: the Office of Research, Development and Technology (RDT) (appropriated funds) which administers several programs, including the University Transportation Centers (UTC) Program (HTF funded); Intelligent Transportation System-Joint Program Office Program (ITS-JPO) (HTF funded); Bureau of Transportation Statistics (BTS) (HTF funded); Positioning, Navigation, and Timing and Spectrum Management (PNT) (appropriated funds); Transportation Safety Institute (fee-for-service); and Volpe National Transportation Systems Center (fee-for-service).

University Transportation Centers (UTC) Program

OST-R receives an allocation from the FHWA to fund the UTC program. The FAST Act authorized $77,500,000 for the program in FY19. The UTC program is a competitive grant program for colleges and universities and is the primary mid- to long-term surface transportation R&D program at DOT. Grants last for the duration of the surface transportation authorization act

[2] Kirk, Robert. S and Mallet, William J., "Highway and Public Transit Funding Issues," Congressional Research Service, June 4, 2019.
https://www.crs.gov/Reports/IF10495?source=search&guid=7cf4cfb47224411192b98921e383eac9&index=2

and a new competition starts for all centers after each reauthorization. The role of UTCs is to advance transportation expertise and technology through education, research, and technology transfer, to provide a transportation knowledge base outside of DOT, and to address workforce needs.

Under the FAST Act, all UTCs are a consortia of institutions of higher education. Each UTC must address one of six research priorities under the Secretary's Five-Year research and development strategic plan which are outlined in law, including 1) improving mobility of people and goods; 2) reducing congestion; 3) promoting safety; 4) improving the durability and extending the life of transportation infrastructure; 5) preserving the environment; and 6) preserving the existing transportation system.

The FAST Act authorized five National UTCs, 10 regional UTCs, and up to 20 Tier 1 UTCs. One of the regional UTCs must focus its research in the field of comprehensive transportation safety, congestion, connected vehicles, connected infrastructure, and autonomous vehicles. The FY18 appropriations provided $15 million in funding for the creation of two new national UTCs, one on congestion research and one on infrastructure. Grant recipients in each category of UTC must provide a match to the federal funding. This match generally comes from state funding.

Federal Highway Administration (FHWA) Research

In addition to the three HTF-funded programs administered by OST-R, the FHWA also carries out highway related research at the Turner-Fairbank Highway Research Center in McLean, Virginia and funds research projects carried out by states. As required under the FAST Act, the FHWA administers and funds four major research programs:

- Highway Research and Development Program. – This program is funded at $125 million in FY19. One of the programs under this program is the Exploratory Advanced Research (EAR) Program, which focuses on longer-term, higher risk research. The program did not receive a line-item authorization in either of the most recent surface transportation bills. TRB has recommended that FHWA do more in the area of long-term research projects.
- Technology and Innovation Deployment Program, funded at $67.5 million in FY19. – Under this program, the FAST Act authorized $60 million per year for the new Advanced Transportation and Congestion Management Technologies Deployment (ATCTMD). This program is funded from funds set aside for the Highway Research and Development Program and the Intelligent Transportation Systems Program.
- Training and Education, funded at $24 million in FY19.
- Intelligent Transportation Systems Program, funded at $100 million in FY19. This is the second largest research account at FHWA and focuses largely on connected and autonomous vehicle research. FHWA is required to consult with other relevant modal administrations in carrying out this program.

State Planning and Research (SP&R)

The Federal-aid highway program, funded by the HTF (and transfers), allocates funding to states for highway construction, bridges, safety improvements, freight, congestion mitigation and air quality improvement, and transportation planning. Two percent of a state's Federal-aid highway allocation is set-aside for planning. Of that two percent, 25% must be used for research. Total annual SP&R funding for all states was $200 million in 2018.[3] States carry out "pooled fund" projects with other states and partners to leverage these funds. State DOTs focus heavily on applied research to address immediate transportation challenges. UTCs partner with states on research and generally receive the matching funds required for the UTC program from SP&R funds.

Federal Transit Administration (FTA)

The FTA carries out and administers public transportation research funds provided under the FAST Act. Out of the Mass Transit Account of the HTF, Public Transportation Innovation receives $28 million annually and Technical Assistance and Workforce Development receives $9 million annually.

Federal Research Partners

The Transportation Research Board (TRB) is an organization within the National Academies and carries out many Congressionally mandated and agency sponsored cooperative transportation research programs. These programs include the National Cooperative Highway Research Program, Transit Cooperative Research Program, Airport Cooperative Research Program, Behavioral Traffic Safety Cooperative Research Program, National Cooperative Freight Research Program, Hazardous Materials Cooperative Research Program, and the National Cooperative Rail Research Program.

TRB also carries out assessments of agency programs, including through the Research and Technology Coordinating Council (RTCC), which reviews the highway research, development, and deployment efforts of the FHWA. In 1987, Congress also authorized TRB to carry out a five-year applied research program called the Strategic Highway Research Program to improve highway performance, durability, safety, and efficiency. The program was reauthorized from 2006 through 2015, but was not reauthorized under the FAST Act.

[3] Transportation Research Board. http://www.trb.org/ResearchFunding/StateDepartmentofTransportation.aspx

Chairwoman STEVENS. This hearing will come to order. Without objection, the Chair is authorized to declare recess at any time. Good afternoon, and welcome to this hearing to review surface transportation research. We appreciate our expert witnesses for being here, and we really look forward to your testimony. The name of this hearing is "Bumper to Bumper" because it adequately describes the commute so many Americans experience on a daily basis, making their way on deteriorating roadways and bridges.

The U.S. population has nearly doubled since construction of our national highway system, which was created in 1956, including the Nation's first border-to-border interstate highway in Michigan. And, in fact, Michigan has a very robust highway history, being the home to the Nation's first four-way red/yellow/green electric traffic light. That was erected at the corner of Woodward and Michigan Avenues in Detroit, and the light was the invention of a Detroit police officer, William Potts. All of our great innovations and efforts in surface transportation has led to, you know, incredible efforts, but it has also led to immense congestion, which cost the U.S. $305 billion in 2017 alone from lost productivity, increased shipping costs, and wasted fuel. The American Society of Civil Engineers—this is often well cited and well known, but I'm going to say it in my opening testimony just to make sure it's fully absorbed—has given our Nation, the United States of America, a D+ in its most recent infrastructure report card, citing our transportation infrastructure woes.

Transportation in other countries serves as a beacon of the future, and contributes to productivity and economic success. Conversely, America's transportation system is contributing to the demise of our human and climate health. Traffic fatalities have been steadily rising since 2011, after many years of declining. The fourth National Climate Assessment reported that in 2016, transportation became the top contributor to greenhouse gas emissions. In short, our current transportation infrastructure is in dire straits, and, despite that, it is shockingly underfunded. It is not surprising that research may not be the highest priority for transportation managers, who are just trying to keep their bridges from collapsing.

However, investing in research and development (R&D) is still critical to developing smart, resilient, and cost-effective transportation infrastructure for the future. Where would our auto industry be if DARPA (Defense Advanced Research Projects Agency) hadn't funded the grand challenge that catalyzed today's connected and automated vehicle (CAV) technologies? Unfortunately, the public sector investment in transportation research has been declining. For example, the Federal Highway Administration's exploratory Advanced Research Program, which focuses on longer-term, higher-risk research has been funded at only $6 million a year out of an overall R&D budget of $600 million. This research is critical to inform the policies of transportation agencies at all levels of government to make infrastructure investments that will help to grow innovation and transportation technologies, while keeping people safe, and reducing traffic congestion.

We have a witness today from southeastern Michigan, Dr. Henry Liu, who is a Director at the University of Michigan Transportation Research Institute, which has been doing critical work for traffic

control, driver safety, and future technology in my district, and all across the country. Welcome, Dr. Liu. University Transportation Centers (UTCs), such as the one at the University of Michigan, support excellent research, but they also struggle in balancing the long-term research goals with short-term, lower-risk research projects to meet the more immediate needs of cities and States. We want to ensure that transportation researchers with good ideas are able to get funding from the Department of Transportation (DOT) to pursue those ideas. By the way, our Science Committee's Subcommittee for Research and Technology does have some oversight and jurisdiction into the Department of Transportation R&D programs, so we must also ensure that federally funded research that does lead to promising innovations finds its way into practice.

In the meantime, the private sector is investing heavily in autonomous vehicles and other forms of smart transportation technologies. While these companies partner with local and State governments, as well as the Department of Transportation to test their technologies in the real world, there is no national guiding vision for the smart infrastructure of the future. The private sector is waiting for us. There is also a lack of certainty in the regulatory environment, slowing innovation in these companies. I am so proud to represent my district, that is home to so many small and medium-sized manufacturers, and my claim to brag, the country's most robust automotive supply chain, and they're leaders in this auto industry, driving the success on innovation, safety, green and autonomous vehicle technologies as we push toward a vision of zero fatalities in auto accidents. That's a vision for us. The private sector excels at innovating when the markets are there, but companies will continue to be focused on short-term innovation cycles to do what is best for their workers and their bottom lines. We know that research feeds the pipeline of innovation and innovators. The Federal Government must redouble our efforts on mid- to long-term research, while continuing to partner with the private sector, and States, on shorter-term needs. It sounds like a best practice to me.

The most recent surface transportation law, the *FAST Act* (*Fixing America's Surface Transportation Act*), expires in September 2020. It's coming. The Science Committee is looking forward to engaging with the transportation research community on recommendations for impending reauthorization, which is what we are doing here today. I look forward to exploring this long-term vision for transportation research focused on finding solutions to existing challenges, and ensuring adequate planning and connectivity for the future, and we thank all of you for joining us here today.

[The prepared statement of Chairwoman Stevens follows:]

Good afternoon and welcome to this hearing to review surface transportation research. We appreciate our expert witnesses for being here and we look forward to your testimony.

The name of this hearing is "Bumper to Bumper" because it adequately describes the commute so many Americans experience on a daily basis, making their way on deteriorating roads and bridges.

The U.S. population has nearly *doubled* since construction of our National Highway System began in 1956 - including the nation's first border-to-border interstate highway in Michigan!

This has led to immense congestion, which cost the U.S. $305 billion dollars in 2017 alone from lost productivity, increased shipping costs, and wasted fuel.

The American Society of Civil Engineers gave our nation a D+ in its most recent infrastructure report card.

Transportation in other countries serves as a beacon of the future and contributes to their productivity and economic success. Conversely, America's transportation system is contributing to the demise of human and climate health.

Traffic fatalities have been steadily rising since 2011, after many years of declining.

The Fourth National Climate Assessment reported that in 2016, transportation became the top contributor to greenhouse gas emissions.

In short, our current transportation infrastructure is in dire straits, and despite that, it is shockingly underfunded. It is not surprising that research may not be the highest priority for transportation managers who are just trying to keep their bridges from collapsing.

However, investing in research and development is critical to developing smart, resilient, and cost-effective transportation infrastructure for the future.

Where would our auto industry be if DARPA hadn't funded the grand challenge that catalyzed today's connected and automated vehicle technologies?

Unfortunately, the public sector investment in transportation research has been declining. For example, the Federal Highway Administration's Exploratory Advanced Research program, which focuses on longer-term, higher risk research, has been funded at only $6 million per year out of an overall R&D budget of $600 million.

This research is critical to inform the policies of transportation agencies at all levels of government to make infrastructure investments that will help to grown innovative transportation technologies while keeping people safe and reducing traffic congestion.

We have a witness today from southeastern Michigan, Dr. Henry Liu, who is a Director at the University of Michigan Transportation Research Institute, which has been doing critical work for traffic control, driver safety and future technology in my district and across the country.

University Transportation Centers, such as the one at the University of Michigan, support excellent research, but they also struggle in balancing long-term research goals with short-term, lower-risk research projects to meet the more immediate needs of cities and states.

We want to ensure that transportation researchers with good ideas are able to get funding from the Department of Transportation to pursue those ideas. We must also ensure that federally-funded research that *does* lead to promising innovations finds its way into practice.

In the meantime, the private sector is investing heavily in autonomous vehicles and other forms of smart transportation technologies.

While these companies partner with local and state governments as well as the Department of Transportation to test their technologies in the real world, there is no national guiding vision for the smart infrastructure of the future. There is also a lack of certainty in the regulatory environment, slowing innovation in these companies.

I am proud to represent a district that is home to many of the small and medium manufacturers that are leaders in the supply chain of the U.S. auto industry, driving their success in innovative safety, green, and autonomous technologies.

The private sector excels at innovating when the market drivers are there. But companies will continue to be focused on short-term innovation cycles to do what is best for their workers and their bottom lines.

We know that research feeds the pipeline of innovation and innovators. The Federal government must redouble our efforts on mid to long-term research, while continuing to partner with the private sector and states on shorter-term needs.

The most recent surface transportation law, the *FAST Act*, expires in September 2020. The Science Committee is looking forward to engaging with the transportation research community on recommendations for the impending reauthorization. I look forward to exploring a long-term vision for transportation research focused on finding solutions to existing challenges and ensuring adequate planning and connectivity for the future.

Thank you.

Chairwoman STEVENS. Before I recognize our fabulous Ranking Member, Dr. Baird, for his opening statement, I would also like to take a minute to present for the record a statement from the Intelligent Transportation Society of America in support of increasing research and technology investments in the *FAST Act*. These are

representatives from the private sector. Their voices are heard. So we will be submitting this letter for the record.

And now the Chair recognizes Dr. Baird for an opening statement.

Mr. BAIRD. Thank you, Chairwoman Stevens. Good afternoon, and thank you for convening this hearing to examine the U.S. Department of Transportation's surface transportation research, development, and technology. All of us on this Committee are aware of the issues which face our Nation's infrastructure. I see it regularly on my drives back and forth between Green Castle, Indiana and D.C., and the anticipated cost of its restoration. To effectively address these challenges, we must support and maintain a healthy, substantive research agenda that informs our State and local transportation initiatives. The research and development activities supported by the DOT are vital to the Nation's prosperity. They strengthen critical infrastructure, and enhance our economic competitiveness, and enrich our own way of life.

In 2019, DOT will sponsor more than a billion dollars' worth of research, development, and technology deployment that will have an influence—the majority focused on surface modes of transportation. Advancement in materials and technology can help achieve long-term cost savings by reducing congestion, improving durability, and the lifespan of transportation projects. Today's hearing will be an opportunity for this Committee to examine our Nation's research, development, and technology priorities, and to learn more about policy issues for the future of surface transportation. It will also provide a chance to hear about research being conducted by the universities and the private sector, and how these advancements are being utilized by State and local governments.

I'm glad to welcome Dr. Darcy Bullock from my home State of Indiana, who will talk about the work of the Joint Transportation Research Program (JTRP). JTRP is facilitating public-private partnerships among public agencies, academia, and industry to conduct research and testing that is solving real-world transportation problems in Indiana, and across the Nation. The innovative research and new technology advancements generated by JTRP has saved billions of dollars, and thousands of lives, in Indiana, as well as around the United States. For example, JTRP developed traffic signal performance measures that have been integrated into almost every new traffic signal control system in the United States. These new performance measures allow agency personnel to assess the quality of traffic signal performance, including identifying locations with high volume of red light running, and adjust accordingly to keep our roads safe, and running as smoothly as possible. The work done at JTRP is a great example of how science can yield solutions. It shows how efficient targeted research and development can help develop new innovative ideas and technologies that will make our transportation systems safer. Today's hearing is the first step for the Committee in considering and developing the next reauthorization of Federal surface transportation research, development, and technology programs.

As we move through the process, this Committee must ask difficult questions to determine how best to address the issues facing our sagging and aging infrastructure within the limitations of our

current budget environment. I hope today's hearing will help us guide DOT to set the R&D priorities, and chart a course for a strategic plan that will address our Nation's most urgent transportation needs. I would like to thank all of our witnesses for coming today, and for sharing your thoughts on how to improve our transportation networks and research activities. Thank you, and I yield back the balance of my time.

[The prepared statement of Mr. Baird follows:]

Good afternoon Chairwoman Stevens. Thank you for convening today's hearing to examine the U.S. Department of Transportation's (DOT) surface transportation research, development and technology activities.

All of us on this Committee are aware of the issues with our nation's infrastructure - I see it regularly on my drives between Greencastle and D.C. - and the anticipated costs of its restoration.

To effectively address these challenges, we must support and maintain a healthy, substantive research agenda that informs our state and local transportation initiatives.

The research and development activities supported by the DOT are vital to the nation's prosperity - they strengthen critical infrastructure, enhance our economic competitiveness, and enrich our way of life.

In 2019, DOT will sponsor more than $1 billion in research, development, and technology deployment activities, with the majority focused on surface modes of transportation.

Advancements in materials and technology can help achieve long-term cost savings by reducing congestion and improving the durability and lifespan of transportation projects.

Today's hearing will be an opportunity for this Committee to examine our nation's research, development and technology priorities and to learn more about important policy issues for the future of surface transportation.

It will also provide a chance hear about research being conducted by universities and the private sector and how these advances are being utilized by state and local governments.

I am glad to welcome Dr. Darcy Bullock, from my home state of Indiana, who will talk about the work of the Joint Transportation Research Program (JTRP). JTRP is facilitating public-private partnerships among public agencies, academia and industry to conduct research and testing, that is solving real world transportation problems in Indiana and across the nation.

The innovative research and new knowledge generated by JTRP has saved billions of dollars and thousands of lives in Indiana and the United States.

For example, JTRP developed traffic signal performance measures that have been integrated into almost every new traffic signal control systems in the United States.

These "Purdue Performance Measures" allow agency personnel to assess the quality of traffic signal performance, including identifying locations with high volume of red light running, and adjust accordingly to keep our roads safe and running as smoothly as possible.

The work done at JTRP is a great example of how science can yield solutions.

It shows how efficient, targeted R&D can help develop new innovative ideas and technologies that will make our transportation systems safer.

Today's hearing is the first step for this Committee in considering and developing the next reauthorization of federal surface transportation research, development and technology programs.

As we move through this process, this Committee must ask difficult questions to determine how best to address the issues facing our ageing infrastructure within the limitations of our current budget environment.

I hope today's hearing will help us guide DOT to set R&D priorities and chart a course for a strategic plan that will address our nation's most urgent transportation needs.

I would like to thank all our witnesses for coming today and sharing your thoughts on how to improve our transportation networks and research activities.

Thank you and I yield back the balance of my time.

Chairwoman STEVENS. If there are any other Members who wish to submit additional opening statements, your statements will be added to the record at this point.

[The prepared statement of Chairwoman Johnson follows:]

Thank you Chairwoman Stevens and Ranking Member Baird for holding this hearing, and thank you to the witnesses for your participation. In addition to being chairwoman of this Committee, I am also a senior Member of the Transportation and Infrastructure Committee. While there is great expertise about transportation issues on my other committee, the Science Committee is where we truly understand the importance of research to developing smart solutions to our nation's challenges. As we all know, our outdated transportation infrastructure is high on our list of challenges.

My hometown of Dallas is a hub for air travel and freight. We have five interstate highways, we have the DART light rail, we are trying to build a high-speed rail line to Houston, and of course in Texas we love our cars. Dallas is even going to serve as a test site for the Uber Elevate project to develop flying cars. So we know a few things about inland modes of transportation. However, we have our share of transportation challenges. Dallas is the fifth-most-congested city in the nation, in large part because we are one of the most rapidly growing cities in the nation. As we continue to look for ways to increase safety and alleviate congestion in the near term, we must also set a course for smart transportation systems of the future. That will require investments in research and technology.

I have long been a champion for the research and development programs at the Department of Transportation. These programs require strong partnerships with local and state governments to help identify the needs. They also involve strong partnerships with the private sector. However, we need a good balance between long-term research that looks over the horizon, and nearer-term research to address more immediate needs. We also need a transparent system in which the best ideas rise to the top for funding. Currently, the Department of Transportation has a 5-year strategic plan for research, development, and technology. The plan covers a lot of important topics in great detail. What it seems to lack is a coherent vision for the future of connected transportation systems. I am concerned that, absent such a vision, we are not sufficiently investing in the long-term research that will make our transportation systems more efficient, safer, environmentally friendly, and resilient.

I look forward to hearing from today's expert panel of witnesses as we consider ideas for reauthorization of the research, development and technology programs at the Department of Transportation.

Thank you and I yield back.

Chairwoman STEVENS. I'd also like to, at this time, introduce our full panel of witnesses.

Our first witness is Mr. Timothy Henkel. Mr. Henkel is the Chair of the Research Coordinating Committee of the Transportation Research Board, and is also the Assistant Commissioner for Modal Planning and Program Management in the Minnesota Department of Transportation. In his role as Assistant Commissioner, he manages a number of offices, including the Offices of Transportation System Management, Transportation Data and Analysis and Research. He earned his bachelor's of science from—how do we say it?

Mr. HENKEL. Bemidji State University.

Chairwoman STEVENS. Bemidji State. And where's it located?

Mr. HENKEL. Northwestern Minnesota.

Chairwoman STEVENS. Fabulous. We're glad to learn a little bit more about Northwestern Minnesota here today. And a certificate in civil engineering and land surveying from Dunwoody College.

Our next witness is Mr. Brian Ness. Mr. Ness is the Director of the Idaho Transportation Department, and Chair of the American Association of State Highway and Transportation Officials (AASHTO) Special Committee on Research and Innovation. He also serves on the Transportation Research Board's Executive Committee, and their Subcommittee on Planning and Policy Review. Mr. Ness earned a bachelor of science degree in civil engineering from Tri-State University, and a Master's Degree in Public Administration from Western Michigan University, so go Broncos.

After Mr. Ness is officially Dr. Henry Liu. Dr. Liu is the Director of the Center for Connected and Automated Transportation, and is also Professor of Civil and Environmental Engineering at the University of Michigan, Ann Arbor. Dr. Liu's research focuses on transportation network monitoring, modeling, and control, as well as mobility and safety applications involving connected and automated vehicles. He received his bachelor's degree in automotive engineering from—you can say it—Tsinghua University. And where's it located?

Dr. LIU. In Beijing.

Chairwoman STEVENS. Beijing? And his Ph.D. in civil and environmental engineering from the University of Wisconsin, Madison. Badgers.

Our final witness is Dr. Darcy Bullock. Dr. Bullock is the Director of the Joint Transportation Research Program, and serves as the Lyles Family Professor in the Lyles School of Civil Engineering at Purdue. We've got some Big Ten love going on here, guys, OK? And we're an interconnected country, all right? I mean, this is why this highway conversation is not a snoozer. It's paramount to a lot of economic success, healthcare outcomes, and on.

So Dr. Bullock has completed projects with the Federal Highway Administration National Cooperative Highway Research Program, National Science Foundation, and a number of State and local transportation agencies. He received a B.S. in civil engineering from the University of Vermont—that was easy to say—and an M.S. and Ph.D. in civil engineering from Carnegie Mellon University.

As our witnesses should know, you will each have 5 minutes for your spoken testimony. Your written testimony will be included in the record for the hearing. When you have completed your spoken testimony, we will begin our questions. Each Member has 5 minutes to ask questions of the panel, and we're going to start with Mr. Henkel. Five minutes, sir.

TESTIMONY OF TIM HENKEL, CHAIR, RESEARCH AND TECHNOLOGY COORDINATING COMMITTEE, TRANSPORTATION RESEARCH BOARD; AND ASSISTANT COMMISSIONER, MODAL PLANNING AND PROGRAM MANAGEMENT, MINNESOTA DEPARTMENT OF TRANSPORTATION

Mr. HENKEL. Good afternoon, Chairwoman Stevens, Ranking Member Baird, and Members of the Subcommittee. I'm really pleased to have been invited to testify here today. I am an Assistant Commissioner for the Minnesota Department of Transportation, but I'm here because I'm also Chair of the National Academies' committee that serves as an independent advisor to the Federal Highway Administration (FHWA) on RD&T (research, development, and technology transfer). My testimony is based on the just-released National Academies' report entitled, "The Vital Federal Role in Meeting the Highway Innovation Imperative". This title reflects two equally important components. First, the imperatives transportation agencies have to innovate in order to address the rapid changes and large challenges we face in meeting the trans-

portation needs of our communities. Second, the vital role of Federal RD&T programs in helping us address these challenges. I will briefly summarize our main findings, and then turn to the purpose of today's hearing, to review U.S. DOT surface transportation RD&T, research initiatives authorized in the *FAST Act,* and the need for a surface transportation research agenda.

Our report assesses the FHWA and Intelligent Transportation Systems RD&T programs by applying congressional criteria for these programs intended to foster innovation and support its deployment. Our review includes the two other federally funded highway-related programs: State Planning and Research (SP&R) and University Transportation Centers Program. For perspective, the annual authorized Federal investment in highway-related RD&T across these four programs totals nearly $600 million, but this amount amounts to only 0.3 percent of the total annual expenditures by all levels of government to build, operate, and maintain roads and highways.

We have two key findings. First, the FHWA and ITS JPO (Intelligent Transportation Systems Joint Program Office) RD&T programs are meeting the criteria established for them by Congress. They are effective, strategically organized programs that are helping States and local agencies meet the innovation imperative. Second, addressing emerging and fast-changing critical issues in transportation is making RD&T even more vital than before, but the ability of Federal programs to fully respond is constrained by available resources. Because highways move the dominant share of freight and passengers, they affect almost all aspects of the economy, society, and daily lives of Americans. Although the scope of the Federal RD&T highways programs are broad, the need to be comprehensive risks spreading resources too thinly. The *FAST Act's* inclusion of $80 million annually for new pilot and demonstration programs without additional funding has increased this risk. Other insights from our report are included in my written testimony. I turn now to comment on how it informs the specific purpose of this hearing.

Regarding RD&T activities, FHWA and ITS programs both foster innovation and assist the States and local agencies in implementing them. FHWA's technology transfer activities are particularly important to State and local agencies' traditional missions in the areas of operations, safety, materials, durability, and performance, asset management, resilience, and many other challenging issues that States and local agencies must manage on a day-to-day basis. However, we find that the portfolios of all four federally funded highway RD&T programs have opportunities to improve in two areas. First, we see need for greater investment in fundamental research to identify future potentially transformative improvements in highway transportation. Universities ought to be the best places for carrying out fundamental research, but the UTC program directives are resulting in an over-emphasis on applied research. Second, we find that expanded investment in evaluation research can help program managers and policymakers better understand how well RD&T programs are working at fostering innovation and how effective the innovations have been once implemented.

Regarding the research provisions of the *FAST Act*, the structure and focus of the FHWA and ITS programs are clearly based on congressional authorizations and priorities. FHWA, for example, is carrying out R&D to help States implement the performance objectives of Congress established in *MAP-21* (*Moving Ahead for Progress in the 21st Century Act*) and the *FAST Act* for safety, congestion relief, freight movement, and asset management.

Regarding a surface transportation research agenda, I return to the wide array of topics that States and local agencies need help with, and the corresponding breadth of the FHWA and ITS JPO program portfolios. The report identifies more RD&T topics that the committee would like to see FHWA address, but we're also aware of the resource constraints. Without additional funding, everything we'd like to add must come at the expense of the existing portfolio, and many of the existing initiatives are important and already inadequately funded. This concludes my oral remarks.

[The prepared statement of Mr. Henkel follows:]

U.S. House of Representatives
Committee on Science, Space and Technology
Subcommittee on Research and Technology

Hearing of July 11, 2019
Bumper to Bumper: The Need for a National Surface Transportation Research Agenda

Rayburn House Office Building, Room 2318

Written Testimony

The Vital Federal Role in Meeting the Highway Innovation Imperative

Timothy A. Henkel

Chair, Research and Technology Coordinating Committee, Transportation Research Board,
National Academies of Sciences, Engineering, and Medicine
and
Assistant Commissioner, Minnesota Department of Transportation

Chairwoman Stevens and Ranking Member Baird. I'm honored to be invited to testify today on the critically important topic of this hearing. I am the Assistant Commissioner for Modal Planning and Program Management in the Minnesota Department of Transportation and also serve as chair of the Research and Technology Coordinating Committee (RTCC) of the Transportation Research Board of the National Academies of Sciences, Engineering, and Medicine. The National Academies has released a report this morning prepared by the RTCC and entitled *The Vital Federal Role in Meeting the Highway Innovation Imperative.* My testimony this afternoon is based on this report.

I understand from my invitation that "the purpose of today's hearing is to review the Department of Transportation's surface transportation research, development, and demonstration and technology transfer activities, examine research provisions of the FAST Act, and explore the need for a national surface transportation research agenda." Our report covers four of the research, development, and technology transfer (RD&T) programs authorized in the FAST Act: the Federal Highway Administration (FHWA) RD&T program, the Intelligent Transportation Systems (ITS) program managed by the USDOT Joint Program Office, the State Planning and Research program, and University Transportation Centers Program.

The RTCC was established in 1992 to advise FHWA on its RD&T. Thus, our focus is on highway research, but, as described in my following testimony, our review of FHWA's program would not be complete without also reviewing the other major federally funded RD&T programs addressing highway and highway-related R&D. Our report covers all three elements of the purpose for today's hearing and I will comment on each of them after summarizing our report.

BACKGROUND AND CONTEXT

To set the context for our report, we note that rapidly advancing technology, new mobility services, increased urbanization, and the growing frequency of severe weather events are changing highway transportation in fundamental ways. Coupled with rising travel demand, growing traffic congestion, more than 35,000 annual motor vehicle fatalities, and constrained highway funding, these developments are causing state and local governments to depend increasingly on innovations to maintain, repair, modernize, and operate their heavily used and aging highway assets. This report assesses whether the FHWA and ITS JPO programs are helping state and local governments meet this innovation imperative.

To make this assessment, our report focuses on whether FHWA and ITS JPO programs are responsive to key criteria for RD&T in support of innovation as set forth by Congress. The report documents how the two programs are meeting these criteria and fulfilling their roles in delivering critical innovations to state and local governments. However, the report also explains why even more capable, effective, and responsive RD&T programs are needed.

KEY FINDINGS

Our most important findings are that:

1. **FHWA and ITS JPO RD&T programs are meeting the criteria established for them by Congress. They are effective, strategically organized programs that are helping states and local agencies meet the innovation imperative to improve highway system safety and performance.**
2. **Addressing emerging and fast-changing critical issues in transportation is making RD&T even more vital than before, but the ability of FHWA and ITS JPO to fully respond is constrained by available resources for RD&T investments.**

Because they move the dominant share of freight and passengers, highways affect almost all aspects of the economy, society, and daily lives of Americans. These effects are highly beneficial but also involve costs. An ongoing stream of innovations is needed for the public-sector owners and operators of the nation's highways to maximize these benefits and minimize these costs. Because of the broad impacts of highways, the investments in innovation must likewise be broadly-based. The innovations must contribute to demands as diverse as increasing traffic safety, highway operating performance, environmental protection, resilience, asset management, technological advancement, materials durability, and sources of funding, among many others.

The federal government has a compelling interest in promoting innovation in highway transportation. FHWA and ITS JPO discharge this interest in highways, in part, by promoting innovation by the 50 states and nearly 40,000 local governments that own and operate highways. Private-sector innovation is also important, but it can be hindered by the many barriers to innovation in the public sector. These barriers include aversion to risk by asset owners, the "low bid" contracting process, limits on the use of proprietary and patented products, and others.

Annual federal investments in highway-related RD&T to foster public-sector innovation are spread across four major programs authorized by Congress: FHWA RD&T, ITS JPO, State Planning and Research (SP&R), and University Transportation Centers (UTCs) (see Figure 1). The annual level of RD&T funding represents 0.3 percent of annual expenditures across all levels of government on roads and highways. This level of investment is even more modest compared with the importance of highways to individuals, society, and the economy.

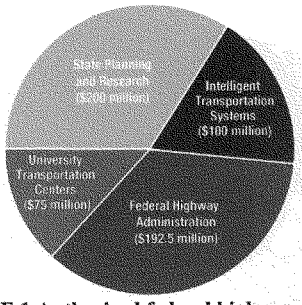

FIGURE 1 Authorized federal highway-related RD&T by program (Fiscal Year 2017).

RESPONSIVENESS TO CONGRESS

In 23 USC 502(a), Congress has set forth several criteria that FHWA and ITS JPO RD&T must meet to foster innovation in highway transportation. Among these criteria, the committee focuses on allocating RD&T resources appropriately across the full innovation cycle, addressing gaps not covered by other programs, and conduct of research on nationally significant topics. In assessing whether the FHWA and ITS JPO programs are meeting these congressional criteria, the committee does so in the context of the two other federally funded, highway-related RD&T programs because of their interrelationships and the similarity of topics addressed.

Full Innovation Cycle

Although innovation is often a non-linear, serendipitous process, innovation in the highway sector can be delineated in five stages: research, development, testing, technology transfer, and evaluation. These stages overlap and interrelate. Evaluation needs to apply to all of the stages in order for continuous improvement to occur in the fostering and delivery of innovation.

Consistent with the requirements of Congress, FHWA and ITS RD&T activities span the full innovation cycle. Almost 60 percent of FHWA's/ITS JPO's RD&T funding is allocated to applied research and development (R&D) according to FHWA and JPO estimates, although it appears that some of these funds could also be classified as pilot testing and technology transfer. FHWA and ITS JPO classify just more than 40 percent of their RD&T funding as technology transfer, although it appears that share could be even larger based on the how program areas are described by FHWA and ITS JPO. The committee's reading of the nature of the work funded in the R&D category suggests that the overall RD&T resource allocation is actually more heavily weighted toward technology transfer than R&D. Given that it generally costs more to promote innovation in the public highway sector than to develop it, such emphasis on technology transfer appears appropriate.

Fundamental Research

Congress has also specified that FHWA's RD&T should include "fundamental, long-term research" to assist in the identification of promising future innovations. Investment in such high-risk research with its broad potential benefits is a clear federal responsibility. FHWA's Exploratory Advanced Research (EAR) program has this focus, but its annual funding ($6 million) is modest and represents but 3 percent of FHWA RD&T. ITS JPO's $18 million Emerging Technologies program is described as potentially supporting fundamental research, but much of the activity appears to be applied R&D, pilot tests, and demonstrations. Across all four of the federally funded highway-related RD&T programs reviewed in this report, almost all of the funding supports applied R&D, testing, demonstrations, and technology transfer. An emphasis on these stages of the innovation process is appropriate given the many practical problems state and local agencies face and their need to make ongoing incremental improvements across a range of challenging issues. However, based on the committee's estimate, the share of funding for these activities is disproportionately large. Inadequate investment in fundamental research risks missed opportunities for insights that might yield future transformative improvements in highway transportation. Universities may be more fertile areas for fundamental research than federal contract research programs, but the funding requirements and structure of the UTC program drives universities to focus on applied research. Congress may want to consider whether changes are needed to UTC program requirements to ensure adequate UTC investment in fundamental research.

Evaluation

Congress has also specified evaluation requirements for RD&T. FHWA and ITS JPO have notable evaluation efforts, but even greater benefits are possible from expanded investment in this area. FHWA RD&T has an important initiative to conduct case-study evaluations of specific RD&T initiatives, but limited funding has constrained the number and extent of evaluations. The ITS program has an ongoing evaluation activity, including the independent evaluation component of its large-scale connected vehicle (CV) pilot projects. Regarding demonstration programs, as directed by Congress, FHWA is requiring annual reports of progress and documentation of lessons learned from grantees, but is relying on self-reports rather than independent evaluations. This raises questions about whether (a) there are better ways to fund and design demonstration programs around strategic objectives and reporting and (b) FHWA could rely on independent evaluation of a sample of demonstration projects rather than relying on self-reports from all of them.

The FHWA and ITS JPO research is spread across many different highway topics, allowing it to contribute positively to the many important aspects of highway transportation. Although the scope of the RD&T program is broad, the emphasis on being comprehensive can lead to resources being spread too thinly. Congress's direction in the Fixing America's Surface Transportation Act of 2015 stating that funding representing $80 million annually in FHWA and ITS RD&T resources be transferred from existing RD&T for new pilot and demonstration programs has exacerbated this risk.

Understanding that deployment of innovation in the highway sector requires serving the states and local governments that own and operate highways, the FHWA and ITS JPO RD&T programs are explicitly designed for this purpose. More than 80 percent of FHWA's RD&T activities identify state DOTs as partners. ITS JPO's large-scale pilot programs and ITS demonstration projects conducted with state and local government partners represent 44 percent of ITS funding, and many of its other programs support state and local government initiatives as well.

Addressing Gaps in Research
FHWA and ITS JPO RD&T programs, as required by Congress, are addressing a number of critical gaps not covered by other programs:

1. *Responsiveness to Congressional Direction.* FHWA RD&T is advancing congressional and federal policy direction in areas such as system performance, asset management, acceleration of project delivery, safety planning, and environmental compliance.
2. *RD&T Coordination.* FHWA provides the pooled-fund contracting mechanism for the dozens of ongoing collaborations in RD&T by states and by states with FHWA.
3. *Advancing City-, Regional-, and State-scale ITS Applications.* ITS JPO RD&T on cybersecurity, system integration, standards for interoperability, development of infrastructure-based sensing and communications systems, operational applications, and support for city-, regional-, and state-scale pilot tests is not being addressed in SP&R or UTC RD&T.
4. *Data Collection and Sharing.* FHWA develops and maintains invaluable, widely used national datasets (travel, safety, asset condition and performance, system extent, and funding among them).
5. *Broad Diffusion of RD&T Information.* FHWA funding and technology transfer activities support broad diffusion of information about ongoing and published transportation research from all sources to policy makers, practitioners, and researchers alike, and FHWA and ITS JPO websites provide extensive information about their RD&T activities.
6. *Support for Innovation from Discovery to Deployment.* FHWA and ITS JPO's stable resources and strategic approach enable them to make long-term commitments, often spanning more than a decade, to identify, develop, test, and demonstrate potentially promising innovations. FHWA and ITS JPO play a critical role in supporting state and local deployment through technology transfer programs that include funding, technical guidance and assistance, training and education, and professional capacity building.

Conduct of Nationally Significant R&D
As described in Chapter 5 of our report, FHWA and ITS JPO RD&T is addressing most of the nationally significant topics identified in TRB's *Critical Issues in Transportation.* Illustrative examples of compelling policy and operational concerns that could drive sustained and additional RD&T include

Transformational Technologies—by (a) continuing to foster interoperability and cybersecurity of rapidly evolving connected and automated vehicle (CAV) technologies, (b) monitoring and forecasting how CAVs will affect highway performance and capacity, and (c) by collecting data about shared mobility travel and sponsoring research on the broad implications of this fast-growing trend.

Energy and Sustainability—by collaborating in R&D with other federal agencies and developing policies on how to best foster the recharging infrastructure needed for electric drive and low-GHG emission fuels for highway transportation.

Serving a Growing and Shifting Population—by addressing how to ensure that megaregions responsible for a growing share of national prosperity are well connected internally and with the rest of the nation and the world; developing funding strategies for highways supporting interstate passenger and freight travel in rural areas with declining populations; and improving the ability to estimate future Interstate highway travel at the network level, including accounting for the ability of passengers and freight to shift the time and routes of trips and to shift to other modes.

Resilience—by collaborating with other federal agencies conducting R&D addressing infrastructure vulnerability to natural and manmade disasters and by developing risk-management tools; incorporating the results from climate research into standards for resilient design; and developing policies and funding strategies regarding the rebuilding of more resilient infrastructure after it is damaged or destroyed.

Safety—by continuing to focus on the potentially transformative safety benefits of technology through ITS RD&T on systems integration; interoperability; sensing and communications to connect vehicles, infrastructure, and vulnerable road users; and continually updated guidance on the public role in development and deployment as private-sector CAV technologies evolve and find market acceptance.

Equity—by conducting R&D to (a) improve transportation access of disadvantaged populations and (b) conduct an updated study to assess whether all classes of vehicles are being charged their fair share of highway costs.

Governance—through (a) more expansive and in-depth policy research on the appropriate federal policy and funding role in interstate highway transportation and (b) research sorting out the trade-offs, responsibilities, and funding roles of the multiple levels of governments involved in highway transportation at the local level.

Asset Management and System Performance—by filling critical knowledge gaps about the structural condition of aged Interstate highway pavement foundations and the extent, condition, and performance of Interstate interchanges.

Funding and Finance—by supporting and managing a large-scale national pilot program to test (a) technologies and systems to allow for direct road user charges and (b) public and political acceptance of these alternatives.

Goods Movement—by conducting research and model development to understand the national policy trade-offs of shifting freight to other modes when considering expansion of Interstate highways. (FHWA RD&T is expanding its work in freight in response to congressional direction, but appears to lack the resources needed to make more substantive progress in this important and complex area.)

Research and Innovation—(a) to foster and support a culture of innovation by states, metropolitan planning organizations, and local highway agencies and (b) by conducting RD&T on ways to expand opportunities for private-sector innovation to occur in highway transportation.

PURPOSE OF TODAY'S HEARING

Regarding the purpose of today's hearing, our report leads to several observations I hope that the Subcommittee members will find helpful. I comment on each component of the purpose in turn.

RD&T Activities

Regarding RD&T Activities, FHWA and ITS JPO programs cover the full innovation cycle in ways that both foster innovation and assist the states and local agencies that own highways in implementing them. FHWA's technology transfer activities are particularly important to state and local agencies' traditional missions because of the wide array of topics FHWA RD&T covers – including operations, safety, materials durability and performance, asset management, resilience, maintenance, environmental protection and many other challenging issues that states and local agencies must manage on a day-to-day basis. ITS JPO RD&T is laying the foundation for achieving the operational and safety benefits from advanced technologies being implemented in connected and automated vehicles. The overall allocation of RD&T resources between fostering innovations and the technology transfer programs that assist states and local agencies in implementing them appears appropriate.

Based on the committee's review of the portfolios of all four federally-funded highway RD&T programs, however, we find them to be weak in two areas. First, we find inadequate investment in the fundamental research that is needed to identify future potentially transformative improvements in highway transportation. FHWA has a good exploratory advanced research (EAR) program but its funding level – just $6 million annually – is rather low. Universities ought to be the best sources for carrying out fundamental research, but the UTC program matching requirements and program directives seeking near term solutions appear to be resulting in a preponderance of applied research that is crowding out fundamental research. We encourage Congress, USDOT, and the UTCs themselves to consider options for changing UTC program policies in ways that would allow for greater fundamental research by UTCs. Second,

despite some notable activities in FHWA and ITS JPO, we find little investment in evaluation research that can help program managers and policy makers understand how well RD&T programs are working at fostering innovation and how effective the innovations have been once implemented. If additional funding is not available for greater investment by FHWA and ITS JPO in fundamental research and evaluation, then these are subjects for reallocating resources within current budgets. We also encourage FHWA and Congress to consider how demonstration programs might be funded and organized differently to ensure clearer objectives and improved reporting. Demonstration programs can be very valuable ways to prove the benefits of innovations that agencies might be reluctant to adopt, but we need better proof of their effectiveness. We understand that gathering rigorous evidence from a large number of demonstration projects can be quite expensive. Evaluating a sample of demonstration projects rather than requiring reporting by all of them might be one way to gather the evidence that will motivate more agencies to risk adopting new innovations.

Research Provisions of the FAST Act

From having reviewed the FHWA and ITS JPO modal research plans and programs in detail in carrying out our analysis, it is clear that the structure and focus of these programs are based on the authorizations of the FAST Act and congressionally-enacted legislation that precedes it. We observe in our report numerous examples of how FHWA and ITS JPO are following congressional direction and advancing congressional priorities. FHWA, for example, is carrying out R&D to help states implement the performance objectives Congress established in MAP-21 and the FAST Act for safety, congestion relief, freight movement, and asset management. It is carrying out FAST Act R&D authorizations to assist states and local agencies in implementing the latest pavement technologies and providing matching grants to states to explore the potential of road user charges to possibly replace our current heavy reliance on motor fuels taxes to pay for the highway programs of the states. The ITS JPO strategic plan and RD&T initiatives that flow from it are based on congressional direction, such as in enhancing (a) ITS architecture and standards for interoperability and (b) professional capacity building to assist states and local agencies in implementing ITS technologies.

Surface Transportation Research Agenda

Regarding a surface transportation research agenda, I return to our recognition of the wide array of highway infrastructure and topics that states and local agencies need help with and the wide array of RD&T topics FHWA and ITS JPO are pursuing in this regard. Our review of some of the FHWA RD&T initiatives, including fundamental research, enhancing freight system performance, and essential areas of data collection, leads us to the conclusion that FHWA has a broad and strong portfolio, but aspects of it are spread quite thinly. There are more RD&T topics

that the committee would like to see FHWA address, but we're also aware of the resource constraints it faces. FHWA and ITS JPO are conducting nationally significant research, but there are compelling policy and operational issues such as the ones mentioned above that would justify greater levels of RD&T investment by the two programs if resources were available.

In closing, we note that the U.S. economy and citizenry depend on highways. In an environment in which transformative changes are occurring in technology, mobility services, climate and weather conditions, and the country's demographic landscape, innovations identified, in part through fundamental research, are desperately needed to harness technology to move highway traffic more quickly, safely, and with fewer adverse environmental impacts. Breakthroughs are needed in materials, construction, long-term asset condition and performance, and means to raise revenues to fund the maintenance and renewal of the highway network. The nation is fortunate to have effective highway RD&T programs at the federal level that are addressing these issues and more. With sustained and adequate funding and modest improvements in RD&T programs such as those suggested above, the programs will continue to serve and advance the national interest and international competitiveness well into the future.

Timothy A. Henkel, Chair of the Research and Technology Coordinating Committee of the National Academies of Sciences, Engineering, and Medicine, is Assistant Commissioner for Modal Planning and Program Management in the Minnesota Department of Transportation. In this position he manages the Offices of Asset Management, Passenger Rail, Transportation System Management, Freight and Commercial Vehicle Operations, Transit, Aeronautics, Transportation Data and Analysis, and Research. His more than 35-year career in transportation includes working with local government, the private sector, executive leadership of multimodal planning, program management, and project development and delivery. He has been a member of the American Association of State Highway and Transportation Officials Standing Committee on Planning and several National Cooperative Highway Research Program panels. He earned a bachelor's of science degree from Bemidji State University and a certificate in civil engineering and land surveying from Dunwoody College.

**TESTIMONY OF BRIAN NESS,
DIRECTOR, IDAHO TRANSPORTATION DEPARTMENT; AND
CHAIR, AMERICAN ASSOCIATION OF STATE HIGHWAY
AND TRANSPORTATION OFFICIALS SPECIAL COMMITTEE
ON RESEARCH AND INNOVATION**

Mr. NESS. Chairwoman Stevens, and Members of the Research and Technology Subcommittee, thank you for the opportunity to appear before you today to discuss the importance of transportation research and innovation. I've worked in the transportation industry for more than 40 years—30 for the Michigan Department of Transportation, and the last 10 years as Director of the Idaho Transportation Department. I am also Chair of the American Association of State Highway and Transportation Officials Special Committee on Research and Innovation. When I became Chair, I implemented a new vision with four requirements. One, we must have a strategic approach to selecting research projects. Two, when possible, these projects should provide a positive return on investment. Three, research should translate into real results in the field, and four, the timeframes must be accelerated.

In addition, the Transportation Research Board, TRB, identified 12 critical issues for 2019 that help guide the selection of research projects. The TRB's cooperative research program invests more than $60 million annually in research for airports, transit, freight, rail, safety, hazardous materials, and highways. State DOTs contribute $50 million annually to fund the projects we believe have a high return on investment, or provide the most benefits to taxpayers. States like Michigan are using tools provided by the Strategic Highway Research Program to find ways to build roads and bridges faster and more efficiently. The money they save allows them to fund more projects.

In Idaho, my department developed a new concrete mix for linking bridge girders, then we partnered on a research project with a university to see how well it performs. The new mix reduces the concrete cost from between $10,000 and $15,000 per cubic yard to $800 per cubic yard, a cost reduction of more than 90 percent. In 2017, Indiana spent $3.9 million on research projects. They're reporting that five of those projects save their State just under $190 million. What a great return on investment, saving $46 for every $1 spent.

Here is an example of how research translates into results in the field. A research project created a new tool called the Incident Command Field Guide. It includes these flash cards that highway crews carry in their trucks. When they come upon an incident, these cards allow them to quickly determine the right course of action for transportation workers responding to the incident, and help them coordinate better with emergency responders, saving time and lives. As Chair of the Research and Innovation Committee, I am sometimes asked, why do we spend money on research? The answer is simple. Research dollars allow DOTs to stretch their transportation money even further. What we save allows us to buy more steel, asphalt, and concrete. Research investments create long-term improvements taxpayers can actually see and benefit from.

We at AASHTO recently published a white paper addressing reauthorization, and the need for continued funding for research and innovation programs to ensure a strong future for the transportation network. In addition to the cooperative research program, we recommend that the *FAST Act* reauthorization provide funding for the State Planning and Research Program and the Federal Research Technology and Education Program, among others, at their historic level, plus inflation. We also recommend $1 million to fund scoping for a third strategic research program. As you look at reauthorization, AASHTO urges you to ensure State flexibility by retaining the current multi-tiered research structure. Many research projects at the State and Federal level deliver a high return on investment, with significant benefits for commerce and the traveling public. Additional information can be found in my written testimony, and I thank you for the opportunity to address your Subcommittee.

[The prepared statement of Mr. Ness follows:]

AMERICAN ASSOCIATION
OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS

AASHTO

TESTIMONY OF

The Honorable Brian W. Ness, P.E.
Chair, Committee on Research and Innovation, American Association of State Highway and Transportation Officials;
Director, Idaho Transportation Department

REGARDING

Bumper to Bumper: The Need for a National Surface Transportation Research Agenda

BEFORE THE

Subcommittee on Research and Technology of the Committee on Science, Space, and Technology of the United States House of Representatives

ON

July 11, 2019

American Association of State Highway and Transportation Officials
444 North Capitol Street, N.W., Suite 249 | Washington, D.C., 20001
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INTRODUCTION

Chairwoman Stevens, Ranking Member Baird, and Members of the Subcommittee, thank you for the opportunity to appear today and address the critical need for a robust national surface transportation research agenda. My name is Brian W. Ness, and I serve as Director of the Idaho Transportation Department (ITD) and as Chair of the Special Committee on Research and Innovation for the American Association of State Highway and Transportation Officials (AASHTO). Today, it is my honor to testify on behalf of the great state of Idaho and AASHTO, which represents the transportation departments (state DOTs) of all 50 states, Washington, D.C., and Puerto Rico.

After spending 30 years with the Michigan Department of Transportation, I became Director of ITD ten years ago. I lead an agency with an annual budget of $800 million and 1,600 hardworking and dedicated employees. I am particularly proud of our department's employee-driven innovation program started in 2014. Since that time, we have implemented more than 1,000 innovations, saved nearly $9 million, created nearly 600 customer-service improvements, and saved 207,000 contractor and employee hours. ITD was recognized in 2016 by the Idaho Technology Council as a finalist for Innovative Company of the Year, competing against many of Idaho's largest corporations.

In an era of tight funding for state governments across the country, state DOTs rely heavily on research to help solve their most challenging problems. It has been proven time and again that one dollar of research investment today will pay many times that in ongoing future benefits. To assist Congress as it develops research provisions for the next surface transportation legislation (following the Fixing America's Surface Transportation (FAST) Act), I would like to make the following recommendations for transportation research:

- Congress should retain the current, multi-tiered research structure that has delivered a long track record of success.
- For reauthorization of the FAST Act, Congress should consider AASHTO's priority research areas developed through its extensive policy-development process.
- Congress needs to ensure a strategic approach to investment that accelerates the deployment of research findings, creating real results in the field.

CONGRESS SHOULD RETAIN THE CURRENT, MULTI-TIERED RESEARCH STRUCTURE THAT HAS DELIVERED A LONG TRACK RECORD OF SUCCESS

To build, maintain, and expand its vast multimodal transportation system, our nation has long committed to and relied on the fruits of research—including innovations in planning, materials,

construction methods, system operation, organizational effectiveness, and many other areas. Innovation and research allow state agencies to efficiently and effectively deliver a safe, reliable, and sustainable transportation system while continuously improving facilities and services. The federal government's support and funding for transportation research has been steady over many decades, dating back to the 1893 formation of the Office of Road Inquiry in the U.S. Department of Agriculture. However, by any measure—across industries or across countries—our nation invests very modest resources in transportation research and innovation.

A substantial return on investment from smarter, better, and longer-lasting transportation can easily be documented with factors such as more durable infrastructure and improved operations. Additional benefits extend far beyond those that are easily quantified, including lives saved, an environmentally responsible transportation system, and improved quality of life for our citizens whose daily lives depend on the efficient movement of people and goods. I will provide several examples of actual research projects later in this testimony.

Like the federal system of government, transportation research in the United States is a decentralized collection of interrelated programs. The national transportation system has a large geographical footprint, owned and operated by states and localities. Additional key stakeholders include Congress and the U.S. Department of Transportation (USDOT), universities, private firms, associations, and the users of the transportation system. The multi-tiered components of our national transportation research effort supported with federal surface transportation funds include the following:

- Federal research and technology transfer carried out directly by the USDOT, including research directed by the Secretary's policy and research offices, as well as by the modal agencies, including the Federal Highway Administration (FHWA), Federal Transit Administration (FTA), National Highway Traffic Safety Administration (NHTSA), Federal Motor Carrier Safety Administration (FMCSA), and Federal Railroad Administration (FRA). Through the federal program, the USDOT addresses high-priority national research needs and shares new technologies and practices with the states. The USDOT research program is described in more detail later in this testimony.

- Research conducted by each state department of transportation, which is managed by the individual state DOT members of AASHTO's Research and Innovation Committee and its subordinate Research Advisory Committee, coordinate with national research programs and is funded using either federal funds or directly by the states themselves. The majority of the funding for this research comes from the federally-funded State Planning and Research (SPR) Program, which is the nation's cornerstone state research program.

- Various cooperative research programs administered by the Transportation Research Board (TRB) of the National Academies, including the National Cooperative Highway Research Program (NCHRP), Transit Cooperative Research Program (TCRP), Airport Cooperative Research Program (ACRP), and Behavioral Traffic Safety Cooperative Research Program (BTSCRP). Most of these programs determine their research agenda on an annual basis. The sum of these Cooperative Research Programs equal more than $60 million annually in research projects for airports, transit, freight, rail, safety, hazardous materials, and highways. The largest of these programs—NCHRP—is funded through annual voluntary contributions of state DOTs from their SPR funds. NCHRP pools research dollars provided by the states to find solutions to transportation challenges directed by the AASHTO Research and Innovation Committee as critical.

- Policy research undertaken and managed directly by TRB. TRB conducts policy studies examining complex and controversial transportation issues at the request of Congress, executive branch agencies, states, and other sponsors. Studies cover all modes of transportation and a variety of safety, economic, environmental, and research policy issues. A major example is the recently released *Renewing the National Commitment to the Interstate Highway System: A Foundation for the Future* study directed by Congress under the FAST Act.

- Special research authorized by Congress, such as the second Strategic Highway Research Program (SHRP2), which focused on four critical issues in transportation—safety, infrastructure renewal, travel-time reliability, and capacity needs. The results of this targeted research program were implemented successfully over the past six years by FHWA and AASHTO through the use of competitive funding and technical assistance opportunities to transportation agencies across the country.

- The University Transportation Centers (UTC) Program carried out by national, regional, and Tier 1 University Transportation Research Centers (UTCs) that consist of universities across the country focused on specific research areas or topics.

Each of these components plays a vital role in the overall national research effort and, while the efforts are generally independent, there is considerable coordination, collaboration, and communication between these research programs to ensure the development of cohesive, complementary, and significant research. AASHTO firmly believes this multi-tiered federal transportation research and implementation program is best positioned to meet the unique needs of each state.

AASHTO'S RESEARCH POLICY PRIORITIES FOR SURFACE TRANSPORTATION REAUTHORIZATION

To further build on the federal surface transportation program's solid foundation, AASHTO strongly urges Congress to reauthorize the FAST Act in a timely manner by September 30, 2020, without resorting to disruptive short-term extensions of the program. The following surface transportation research issues have been identified as part of AASHTO's FAST Act reauthorization effort:

- Increase funding for the Federal Research, Technology and Education (RT&E) Program. The FAST Act reduced the flexibility of MAP-21 research funding by requiring three congressionally designated efforts to be funded by existing federal research funding sources. AASHTO recommends a minimum budget of $678 million per year to return the federal RT&E programs to former levels.

- Maintain the State Planning and Research (SPR) program in its current, formula-based configuration and continue the 25 percent set-aside for research, development, and technology-transfer activities. This will allow state DOTs to continue their commitments to research and implementation of innovative transportation technologies and processes across the country.

- Reauthorize the Transit Cooperative Research Program (TCRP). Research conducted through the TCRP and directly by the Federal Transit Administration remains a high priority for states. These activities promote best practices and facilitate the deployment of new technologies, thereby increasing operational efficiency. Funding for this program should be preserved.

- Reinstate the National Cooperative Freight Research Program (NCFRP). Throughout its history, a core element of the FHWA's RT&E mission has been to promote innovation and improvement in the highway system. This critical mission element has developed into a broad array of research and technology activities covering the spectrum of advanced research, applied research, technology transfer, and implementation. The National Cooperative Freight Research Program, however, was last authorized under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The Moving Ahead for Progress in the 21st Century (MAP-21) and the FAST Act provided increased emphasis on freight issues while simultaneously reducing funding for freight research at the national level. The NCFRP should be reestablished to assist states in their delivery of freight transportation projects with funding beyond the amount prescribed for the federally managed RT&E and SPR programs.

- Expand Eligible Activities through the National Highway Freight Program to include Research. Reform the National Highway Freight Program and the Nationally Significant Highway and Freight Projects (also known as INFRA) to more clearly include eligibility for investment in integrated freight technology, management and operations strategies and solutions, freight safety programs (including for emergency responders), and research supporting future investments.

- Expand Transit Research Grants and Funding to Explore Mobility Opportunities through Connected and Automated Vehicle Technology. The deployment of Connected and Automated Vehicle (CAV) technology is an unprecedented opportunity to improve transit service delivery. State DOTs are looking to FTA to conduct research, test, and safely deploy these emerging technologies. Funding is needed for research and deployment of CAV technology to enhance mobility alternatives for individuals who may be unable to use or are not served by traditional public transportation services. FTA research should also include an assessment of the impact of CAVs on labor, opportunities to retrain existing employees and train the employees needed in the future to maintain and support these technologies, and assess the infrastructure needed to support deployment.

- Scope a third Strategic Transportation Research Program. Building off the successful implementation of technologies and processes developed through the first and second Strategic Highway Research Programs, AASHTO is recommending $1 million to scope the next Strategic Transportation Research Program. Technology is rapidly changing and increasingly impacting transportation, so potential focus areas for this next strategic research program include: advances in connected and autonomous technologies, incorporating safety-related technologies into our system, addressing infrastructure resiliency, and meeting the needs of multi-modal connectivity.

CONGRESS NEEDS TO ENSURE A STRATEGIC APPROACH THAT ACCELERATES THE DEPLOYMENT OF RESEARCH FINDINGS INTO REAL RESULTS IN THE FIELD

As Chair of the AASHTO Research and Innovation Committee, I established the following vision when selecting and implementing state DOT research projects:

- We must have a strategic approach to selecting research projects.
- When possible, these projects should provide a positive return on investment.
- Research should translate into real results in the field.
- The timeframes must be accelerated.

Estimating the value of research products is challenging. A research product can have multiple outcomes, which in turn can lead to multiple impacts. Significant time can pass between when the research product is developed, when it is put into practice, and when the impacts of that practice are realized. This affects the timing of evaluation activities. The nature of research products is wide-ranging. Some research projects are designed to improve existing practices, others help create policy decisions. Research products provide many types of benefits. Some have measurable returns on investment. Others help agencies improve practices, make policy decisions, or generate benefits to society, such as saving lives or creating cost and time savings. Research projects help AASHTO and the state DOTs address the nation's growing transportation needs.

A notable policy blueprint when it comes to identifying key issues in transportation research is the *Critical Issues in Transportation* developed this year by TRB. It identified the following 12 areas to supplement the wide range of perspectives and practical experience represented by the AASHTO Research and Innnovation Committee membership.

1. **Transformational Technologies and Services: Steering the Technology Revolution**
   All around the globe, companies are testing automated cars, trucks, ships, and aircraft. Test vehicles are already in operation. Some products are almost certain to enter the marketplace in the next few years. Driverless vehicles equipped with artificial intelligence may revolutionize transportation. Perhaps even sooner, vehicles connected to one another with advanced high-speed communication technologies may greatly reduce crashes. How will vehicle automation—along with connected vehicles and shared ride, car, bike, and scooter services—transform society? These revolutionary technologies and services can potentially speed deliveries, prevent crashes, and ease traffic congestion and pollution. How do we determine and guide, as necessary, the direction of these changes? How the future unfolds depends on which technologies and services consumers and businesses embrace and how policy makers respond. While we do not know what the future will bring, the changes could be momentous. For example, if we encourage people to pool rides in driverless electric cars, we could see the service, cost, and environment improve. What policies would best reduce traffic congestion and emissions and improve accessibility for the disabled, elderly, and economically disadvantaged? How do we benefit most from the advent of connected and automated vehicles and potentially transformative transportation services?.

2. **Serving a Growing and Shifting Population**
   The U.S. population is expected to grow about one percent annually, with highway use increasing similarly. But this growth will not be spread evenly across the country. Urban areas are growing faster than rural areas, particularly clusters of metro areas known as "megaregions," while many rural areas decline. At the same time, low-density residential development on the edges of urban areas continues to grow the fastest, which increases traffic and escalates emissions. Although many Millennials are settling in urban centers, more are locating on the edges of cities where Baby Boomers also prefer to live. How do we

adjust to and guide travel demand so we are not overwhelmed with more roads, traffic, and emissions as a result of these geographic preferences? Megaregions in the Northeast, Midwest, South, and West have emerged as economic engines for the economy, but they also have the worst traffic congestion. And their traffic volumes continue to grow faster than new transportation facilities can be built. What are the best policies and modes for improving travel within each megaregion? How do we ensure that megaregions are well connected to the rest of the nation and the world? How can rural populations be ensured adequate access to jobs and services? How is that access changing? Which policies are needed to provide adequate rural access?

3. **Energy and Sustainability: Protecting the Planet**
   Vehicles, planes, ships, and other forms of transport emit more greenhouse gases than any other sector of the economy in the United States. And that share is growing because other sectors of the economy are reducing their emissions faster than transportation. Personal vehicles could rely on electrification using batteries or hydrogen as one way to significantly reduce greenhouse gas emissions. Planes, ships, and trucks pose major obstacles to this objective because of their dependence on fossil fuels that pack more power than alternatives. What are the most effective and cost-effective ways of achieving the drastic reductions needed in fossil fuel consumption? What are the appropriate roles for the public and private sectors in hastening this transition? How can the shift to electric vehicles be accomplished without overwhelming the power grid? Sustainability requires that there be long-term consideration of the implications of decisions and policies on social, economic, and environmental systems. Examples include making decisions based on life-cycle cost considerations and the long-term vitality of communities and key natural environmental systems. How can consideration of long-term sustainability goals be better incorporated into public policy debates and decisions about transportation?

4. **Resilience and Security: Preparing for Threats**
   Recent floods, storms, fires, and hurricanes have disrupted the lives of millions and caused hundreds of billions of dollars in damage. Extreme weather and other natural disasters pose huge and costly threats to the transportation infrastructure. Public officials face the challenge of making vulnerable highways, bridges, railroads, transit stations, waterways, airports, and ports more resilient to climate change and other threats. What policies and strategies would help them meet this challenge? How do we set priorities, cope with disruptions, and pay for these adaptations? Terrorists often choose transportation facilities as their targets. Airports and airlines have increased security to guard against terrorism, but other modes of transport—buses, trains, and ships—are more vulnerable. How do we protect these forms of transport without unduly slowing the movement of people and goods? We also need to address the risks of new technologies. Drones, for example, can be used by terrorists or drug smugglers. Automated vehicles and aircraft are vulnerable to hackers. And all types of transport depend on Global Positioning Systems (GPSs), for which there is no back-up system. How do we make technological advances more secure and resilient?

5. **Safety and Public Health: Safeguarding the Public**
   We depend on motorized transportation, but we pay a price with deaths, injuries, and diseases. Routine highway travel is the source of the vast majority of transport-related deaths in the United States. Even though there have been improvements in vehicles and facilities, most crashes are preventable. How do we muster the political will to adopt the most effective measures to reduce casualties and diseases caused by transportation? How do we encourage the use of the safest vehicle and road designs, reduce alcohol- and drug-impaired driving, and manage operator fatigue? Also, how do we curb driver distractions, especially in semi-automated vehicles that do not require full attention except in emergencies when multitasking drivers may be unprepared to respond? Marijuana legalization and opioid addiction may lead to more people driving while impaired. In addition, pedestrian and cyclist deaths are increasing. What can we do to address these problems? What successes from other countries can be applied? Air pollution comes from many sources, but some transport emissions, such as the particulates from burning diesel fuel, are especially harmful to people. People living near roads, ports, distribution centers, railyards, and airports—often the marginalized and the poor—are exposed to more of these types of vehicle emissions. How do we best address these problems?

6. **Equity: Serving the Disadvantaged**
   The United States is prosperous, but not uniformly. More than 40 million Americans live in poverty. Outside central cities, an automobile is essential for access to jobs and a piece of the American dream, but about 20 percent of households with incomes below $25,000 lack a car. In addition, nearly 40 million Americans have some form of disability, of whom more than 16 million are working age. And the population is aging: the number of people older than 65 will increase by 50 percent from 49 million now to 73 million by 2030. Access to jobs, health care, and other services can be expanded through transportation policies and programs and technology, but these approaches need to be affordable and effective. This is a particular challenge in sparsely populated areas. How do we help disadvantaged Americans get affordable access to work, health care, and other services and to family and friends? What policies would ensure that new technologies and services do not create new barriers to the disadvantaged or to rural residents? Also, as we expand transportation networks, how do we ensure that we are not harming low-income and minority neighborhoods?

7. **Governance: Managing Our Systems**
   A complex web of institutions manages America's transportation services. Many levels of government, from local to national, play important roles. Some functions, such as public transit, airports, and ports, are managed by thousands of special authorities across the country. This spider web of governance frequently limits efficiency. For example, urban transport networks often span jurisdictional boundaries, creating disagreement about which agency is responsible for which aspects of planning, funding, and management. Separate funding streams for specific transportation modes impede efforts to provide travelers with multi-modal options. How do we address these challenges, particularly as

urban areas grow into megaregions? The federal government is responsible for interstate waterways and airspaces and for interstate commerce. However, federal leadership and funding for transportation supporting interstate commerce are waning, forcing state and local governments to take on a larger role. How do we ensure that there are efficient networks for interstate travel and international trade as the federal role declines? New private transportation services efficiently generate enormous data sets about trips. Such data can be helpful to agencies trying to manage system performance. Connected and automated vehicles will add even more information. How can public agencies gain access to these data streams to improve traffic flow while protecting privacy and proprietary information?

8. **System Performance and Management: Improving the Performance of Transportation Networks**
   Highway congestion costs the nation as much as $300 billion annually in wasted time. Flight delays add at least another $30 billion. Clearly, demand for travel is outpacing growth in supply and the increasing congestion is costing us dearly. As the population grows, demand will only increase. However, expanding or building new roads, airports, and other facilities in urban areas is costly, time consuming, and often controversial. How can we serve growing demand in a financially, socially, and environmentally responsible manner? Transportation officials also need to squeeze more performance out of the existing networks. One way to do this is by managing demand: Charging drivers for peak-period travel in congested areas, for example, has the potential to increase ride sharing and generate revenues for transit, bike paths, and sidewalks. While pricing is more effective than other approaches, it is also unpopular. How do we build public and political acceptance for demand-management strategies that work? In the face of tight budgets, transportation officials must also figure out how to maintain the condition of roads, bridges, airports, and other assets for as long as possible. What research would help increase the durability of construction materials and designs? How do we speed adoption of new information to improve the life-cycle performance of transportation assets?

9. **Funding and Finance: Paying the Tab**
   Fuel taxes and other user fees have traditionally paid for highways, bridges, airports, ports, and public transit. These user fees are generally fair and efficient ways to pay for the transportation infrastructure, which is valued in trillions of dollars. However, improving fuel efficiency undermines the revenue potential from the motor fuel taxes that have been the chief funding source for highways and transit. Since 1993, federal officials have not raised the fees that fund the federal share of surface transportation and have instead turned to general revenues. In addition, Congress has declined to raise aviation-related user fees, limiting funds for air traffic control and airports. Although most states have raised motor fuel taxes, state and local government officials are also turning to other sources as the revenues from these taxes decline. One is sales taxes, which can unfairly burden the poor. Also, officials are partnering with businesses to build and maintain roads and other assets. This approach has promising features, but relies on tolls or other charges that are

controversial. With advances in technology, officials can charge highway users by the number of miles traveled. They could also charge more during peak periods to manage demand and more to gas-guzzling vehicles to reduce emissions. But the public is not widely aware of these options and is not enthusiastic about them when it is. Clearly, we need to find new ways to maintain and expand the transportation infrastructure. How do we build understanding of the need to invest in transportation assets, identify the best funding options, and reach consensus for action?

10. **Goods Movement: Moving Freight**
    The economy and our lifestyles depend on an efficient system for moving freight. Although railroads and pipelines are privately owned, funded, and managed, the freight system also requires adequate public infrastructure—roads, airports, ports, and waterways—for private companies to carry the goods needed. Freight movement is expected to grow dramatically in the coming decades to serve the growing population and economy. Without more spending on public infrastructure, this trend could lead to more traffic bottlenecks and capacity problems, especially as overnight and same-day delivery become more popular. How do we provide additional capacity when and where it is needed and ensure that beneficiaries bear the cost? Government officials face the challenges of providing adequate infrastructure for the freight industry while setting a level playing field for competition among private carriers and across transportation modes. In doing so, they need to account and charge for the costs that trucks, aircraft, ships, and other vehicles impose on public infrastructure. This is a process that is both difficult and controversial. How can officials best foster competition and set fair user fees for the freight industry? Another challenge for the freight industry is how to reduce its large and growing share of greenhouse gas emissions. One way to do this is through technology: improving batteries and fuel cells to speed the shift to electric-powered vehicles and moving to automated vehicles. Another is by improving efficiency, such as ensuring more vehicles are carrying freight on return trips. How do we make these improvements effectively and affordably?

11. **Institutional and Workforce Capacity: Providing a Capable and Diverse Workforce**
    Government transportation agencies face huge challenges and tight budgets. Their ability to rise to these challenges depends on having capable workers with the tools they need to do their jobs. These agencies have difficulty competing for and keeping talented workers. They simply cannot pay as much as private industry. How can officials attract and retain the best employees despite the pay disparities between the public and private sectors? Also, the changing nature of transportation is creating different requirements for the workforce. As a result, transportation organizations struggle to keep workers up to date in the skills they need. Automated trucks, trains, vessels, and aircraft will disrupt the transportation workforce in both the public and private sectors. What are the likely impacts of these technological changes on transportation jobs? What are the best ways to help displaced workers? With a growing, changing, and aging population, transportation organizations will need to hire new and diverse employees. How can managers attract more members of underrepresented racial and ethnic groups into the transportation field? How can they

minimize the loss of expertise and experience when Baby Boomers retire?

12. **Research and Innovation: Preparing for the Future**
America is known for innovation. The revolutionary breakthroughs in transportation-related technology happened because of decades of public spending on basic research. In addition, steady improvements in the design, construction, operation, and management of transportation infrastructure has been spurred by research funded by government agencies. Public funding for research and education has never been more important, nor more uncertain. Many experiments are taking place in transportation across the country to meet the challenges of technological innovation and climate change. How do we record, evaluate, and share the results of these experiences and adopt innovations more quickly into standards and practices? Demands on transportation are growing as public spending on transportation research is declining. At the same time, public officials are often discouraged from taking risks. How do we encourage innovation in transportation agencies? How do we speed the pace of research to keep up with the major challenges transportation faces?

All proposed projects are carefully reviewed and prioritized considering the +collective interests of state DOTs. We also look for projects that are projected to result in high return on investment either directly or indirectly—by testing out new concepts or seeding future research—ultimately providing significant value for state DOTS and taxpayers. States like Michigan, Indiana, Ohio, and many others are using tools provided by the Strategic Highway Research Program (SHRP2), to find ways to build roads and bridges faster and more efficiently. The money they save allows them to fund more projects.

For example, Michigan has a 32-acre testing facility for connected and automated vehicle (CAV) technology operated under a partnership with the University of Michigan, the Michigan Department of Transportation, and the international automotive industry. Michigan has several other research projects currently underway, studying topics such as using unmanned aerial vehicles to collect transportation data, and using carbon-fiber reinforcement in bridges to address corrosion caused by salt used to melt snow and ice.

The state of Indiana spent $3.9 million on research projects in 2017, and they report that five of those research projects saved the state just under $190 million. What a great return on investment, saving 46 dollars for every one dollar spent on research!

In Idaho, my department developed a new concrete mix called High Early Strength Concrete, for use in accelerated bridge construction to link bridge girders. Then we partnered on a research project with a university to see how well the product performs. The study proved the new mix can replace Ultra-High Performance Concrete, which costs $10,000 to $15,000 per cubic yard, and reduce the cost to $800 per cubic yard—a cost reduction of more than 90 percent.

Another example is Road Usage Charge (RUC) West, which brings together leaders from 14 state transportation organizations (Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Texas, Utah, and Washington) to share resources and explore innovative revenue solutions to sustainably fund the future of our transportation network.

The traditional revenues currently available for highways and local roads may not be able to preserve and maintain existing road infrastructure, reduce congestion, or improve service. Fuel taxes cannot meet current and long-term transportation funding needs because they continue to lose purchasing power—amounting to about 50 percent for the federal gas tax since its last adjustment 26 years ago. With gradual growth in the alternative-fuel vehicle fleet, states need to explore more sustainable transportation funding models like RUC in order to ensure adequate revenue for road maintenance and improvement. At their annual RUC West Board of Director's meeting in June 2019, the board approved expanding the membership of RUC West to include all state DOT members. This expanded partnership will be operated through the Transportation Pooled Fund Program, which will allow federal, state, and local agencies and other organizations to combine resources to support transportation research studies.

We all want research projects to translate into results in the field. San Jose State University conducted a research project which created an incident-command field guide that includes flash cards highway crews can carry on a key ring in their trucks. When they come upon an incident, these cards allow workers to quickly develop an incident command post, assign the right course of action for transportation workers responding to the incident, and help them coordinate better with emergency responders—saving valuable time, and lives. Here is a link to a short video that shows how the guide and flash cards are used in the field: https://www.youtube.com/watch?v=z93KC7NUqV8

As chair of the Research and Innovation Committee, I am sometimes asked why we spend money on research. The answer is simple—research projects allow state DOTS to stretch their transportation dollars farther. The money we save through research allows us to buy more steel, more asphalt, and more concrete. Research investments create long-term improvements taxpayers can actually see and benefit from.

CONCLUSION

AASHTO cannot stress enough the importance of national surface transportation research and implementation. Multiple and varied efforts are currently underway to move research into practice, and the variety of methods to do this are dependent on the actual results and specific solutions. It takes a wide variety of people in the research community to accomplish all of the objectives in transportation, including developing the data, establishing the needs, conducting the research, sharing the results, and implementing the best ideas.

Testimony of Brian W. Ness, P.E.
Chair, Committee on Research and Innovation, AASHTO
Director, Idaho Transportation Department

By coordinating, collaborating, pooling and leveraging time and money, and utilizing the combined knowledge and expertise of our diverse research community, we are making significant contributions and improvements to the advancement of our nation's transportation system. This decentralized organization of research programs has served the nation well, and should be maintained in the next surface transportation authorization.

I thank you again for the opportunity to testify today, and am happy to answer any question.

Idaho Transportation Department
Director – Brian W. Ness

A life-long transportation professional, Brian W. Ness became Director of the Idaho Transportation Department (ITD) in 2010. He is responsible for an annual budget of $800 million and provides leadership and vision for 1,600 employees.

In April 2018, Director Ness was appointed to the Transportation Research Board's (TRB) Executive Committee and also serves on their Subcommittee on Planning and Policy Review (SPPR). The TRB is a unit of the National Academy of Sciences, Engineering and Medicine, and serves as an independent adviser to the President of the United States, the Congress, and federal and state agencies on scientific and technical transportation issues of national importance.

In March 2017, he became chair of the American Association of State Highway and Transportation Officials' (AASHTO) Special Committee on Research and Innovation. He was President of the Western Association of State Highway and Transportation Officials (WASHTO) in 2016. In this position, he served as a regional representative to AASHTO's Executive Committee. In addition, Director Ness sponsors the WASHTO Highway Transport Committee. He is also the creator and sponsor of WASHTO's Emerging Leaders Program.

Director Ness chaired the AASHTO Special Committee on Transportation Security and Emergency Management (SCOTSEM) until August 2017. Through his leadership of SCOTSEM, he achieved national recognition for applying his organizational model to emergency management and security, which has helped reshape SCOTSEM's strategic plan.

He is a member of the AASHTO Board of Directors, the WASHTO Board of Directors, and the Idaho Rural Partnership's Board of Directors. He is also a member of the Pacific Northwest Economic Region Idaho Council. Director Ness was appointed by the Governor to chair the Idaho Autonomous and Connected Vehicle Testing and Deployment Committee.

Director Ness is a nationally recognized authority on organizational realignment and speaks regularly at national conferences for both the public and private sectors about how to structure a more effective and accountable state government. He leads a seminar each year on his "Nine Steps to a Results-Focused Culture" for the National Transportation Leadership Institute's (NTLI) senior and executive-level management courses.

Director Ness was honored in 2012 as Leader of the Year by the Treasure Valley chapter of Women's Transportation Seminar, and named Trine University's (formerly Tri-State University) 2014 Alumni of the Year. He received the 2016 Navigator Award from the national organization, Route Fifty. The award, in the "Agency and Department Chiefs" category, is based on his citizen-focused approach to government and transformative style. In 2013, ITD earned AASHTO's President's Award for Administration for its realignment efforts. Since Director Ness joined the department, ITD has received nearly 140 national awards for its programs and projects, including the prestigious Francis B. Francois Award for Innovation.

Under Director Ness' leadership, ITD began an employee-driven innovation program in 2014. Since that time, the department has implemented more than 1,000 innovations, saved nearly $9 million, created nearly 600 customer-service improvements, and saved 207,000 contractor

and employee hours. The department was recognized in 2016 by the Idaho Technology Council as a finalist for Innovative Company of the Year.

Director Ness earned a Bachelor of Science degree in Civil Engineering from Tri-State University and a Master's degree in Public Administration from Western Michigan University. He is a licensed professional engineer in Michigan and Idaho. Before becoming director at ITD, he worked for 30 years at the Michigan Department of Transportation (MDOT), holding a variety of positions in research, operations, aeronautics, construction, and project development. Director Ness ended his career with MDOT as the North Region Administrator/Engineer.

TESTIMONY OF DR. HENRY LIU,
DIRECTOR, CENTER FOR CONNECTED AND AUTOMATED TRANSPORTATION; AND PROFESSOR, DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING, UNIVERSITY OF MICHIGAN, ANN ARBOR

Dr. LIU. Good afternoon Chairwoman Stevens, Ranking Member Baird, and the Members of the House Subcommittee on Research and Technology. Thank you for the opportunity to participate in today's hearing. My name is Henry Liu, and I am a professor in the Department of Civil and Environmental Engineering at the University of Michigan, and a research professor at the University Transportation Research Institute. I'm also the Director of U.S. Department of Transportation's Midwest Regional Center for Connected and Automated Transportation, or as we call it, CCAT. In my role, I'm fully aware of the U.S. leadership in evolution of transportation and mobility. I believe it is because ongoing support from the U.S. Government in funding research, and specifically funding University Transportation Centers like CCAT, that gives us this advantage. However, without increased funding that advantage is ours to lose.

CCAT is a consortium of academic institutions in the Midwest, and its members were selected for their specific expertise. Our mission is to significantly impact the evolution of next-generation transportation systems. We do that by focusing on research, education, and workforce development, tech transfer, and outreach. Research conducted at CCAT includes modeling and implementation, enabling technologies, as well as policy and planning. We also have conducted research in the areas of traffic control and operations, infrastructure design and management, as well as human factors.

A central feature of CCAT's approach is to test and demonstrate emerging technologies and concepts by leveraging the inaugural connected vehicle test environment, a unique leading laboratory that has equipped urban streets and highways with communication devices, in addition to thousands of connected vehicles. We also leverage Mcity, the world's first closed test facility for connected and automated vehicles, or CAVs, developed at University of Michigan. Since 2017, we have held two global symposiums on connected and automated vehicles, events that have brought together industry and academia to discuss the path toward a national deployment. We also hold quarterly seminars that dive into specific topics, such as efficient freight movement, the state of our infrastructure, and smart communities.

The UTC program has provided funding to a wide variety of centers since the late 1980s. There are currently 37 UTCs collaborating with more than 120 universities throughout the country. In addition to Federal funds, these centers leverage funding from private, State, and local sponsors to conduct research, develop the future workforce, and test innovations which make our transportation safer, more efficient, and more secure. Clearly more research work needs to be done for a connected and automated transportation system, and more support needs to be available, and we need a national transportation research agenda. We need to continue to invest in advanced technology development, particularly

pre-competitive technologies that enable large-scale CAV deployment. It is also critical that we focus on infrastructure. Beyond just fixing the roads and bridges, we need to deploy a connected infrastructure network that will accelerate vehicle automation. We need to better understand the direct consequences of vehicle automation, such as impacts on employment, social equity, and accessibility, as well as the indirect consequences, such as population distribution, property value, and other aspects of the economy.

University Transportation Centers, like CCAT, are funded through the *FAST Act*. The *FAST Act* is essential to supporting research infrastructure development and the rapid deployment of these technologies across the country. In order to ensure the continued U.S. leadership in transportation, it is more important than ever for Congress to reauthorize the UTC program with increased funding. Thank you again for the opportunity to testify today, and I'm happy to answer any questions you might have.

[The prepared statement of Dr. Liu follows:]

UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

Bumper to Bumper: The Need for a National Surface Transportation Research Agenda

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University of Michigan, Ann Arbor

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11 July 2019
Washington, DC

Good afternoon Chairwoman Stevens, Ranking Member Baird and Members of the House Committee on Science, Space, and Technology Subcommittee on Research and Technology. Thank you for the opportunity to participate in today's hearing entitled, "Bumper to Bumper: The Need for a National Surface Transportation Research Agenda."

My name is Henry Liu and I am a Professor in the Department of Civil and Environmental Engineering at the University of Michigan and a Research Professor at the University of Michigan Transportation Research Institute. I am also the Director of the U.S. Department of Transportation's (DOT's) Region 5 University Transportation Center (UTC), Center for Connected and Automated Transportation, or as we call it,

CCAT. My research has been focused on transportation systems modeling and control with emphasis on the development of connected and automated vehicle (CAV) applications. In the past, my students and I have filed and obtained a number of U.S. patents, some of which have been funded by CCAT and have been implemented in the real world. In my role I am fully aware of the U.S. leadership in the evolution of transportation and mobility. I believe it is because of the ongoing support from the U.S. government in funding research and specifically funding UTCs like CCAT that gives us this advantage. However, without increased funding - that advantage is ours to lose.

Transportation is integral to society. However, there are increasing concerns with the existing transportation system: fatalities/injuries, congestion, and pollution. Every day on average in the United States, 100 people lose their lives on our roadways. In 2017, U.S. drivers spent an average of 41 hours a year in traffic during peak hours, which cost an average of $1,445 per driver. Congestion also produced 56 billion pounds of carbon dioxide (CO2) pollution and contributed to 3.1 billion gallons of wasted fuel in 2015. In addition, at least two societal trends, urbanization and the aging population, demand a fundamental reassessment of the future transportation system. CAV technologies hold the potential to substantially improve traffic safety and reduce traffic congestion, fuel consumption and emissions.

Today's hearing takes place at an important time. Driven by the rapid development of CAV technologies, we are on the cusp of a new revolution in transportation safety and mobility on a scale not seen since the introduction of automobiles a century ago. Although CAV technologies will continue their steady advance towards incorporation into public roadway systems, there exist a variety of

open questions and issues on technology development, policy and planning, and system design and operations that require answers and resolution.

My testimony today will be focused on the following three topics:

1. An overview of CCAT.
2. The impacts of the FAST Act on the UTC program and recommendations for improvements to the UTC program.
3. Needs and challenges to developing a national surface transportation research agenda.

Let me state at the outset, that the opinions I express are my own and do not necessarily represent those of the University of Michigan.

Overview of Center for Connected and Automated Transportation

CCAT was selected for funding by USDOT under the FAST Act which required that one Regional UTC address the field of comprehensive transportation safety, congestion, connected vehicles, connected infrastructure, and autonomous vehicles [49 U.S.C. 55-5(c)(3)(E)]. CCAT is a regional consortium of universities comprised of the University of Michigan at Ann Arbor (U-M), Purdue University, University of Illinois at Urbana-Champaign (UIUC), University of Akron (UA), Central State University (CSU), and Washtenaw Community College (WCC).

Located at the focal point of the U.S. auto industry, CCAT plays a unique regional role in promoting connected and automated transportation research, education, workforce development and technology transfer activities, which are of critical importance to the future of the region's economy. CCAT aims to provide national and

regional leadership for connected and automated transportation research, education, training, and deployment. The CCAT team's extensive and substantive collaborations with stakeholders such as the region's state DOTs, local governments and the CAV industry ensure that our research translates to practical outcomes through prototypes, field tests, technology transfer, implementation, and policies.

CCAT's research focuses on overarching issues related to connected and automated transportation system (CATS) planning, design, and operations that affect transportation agencies and the general public. CCAT research thrusts include CATS' enabling technologies, CATS' modeling and implementation, CATS' control and operations, CATS' infrastructure design and management, CATS' policy and planning, and CATS' human factors. Sample research topics include traffic flow characteristics and operations for mixed streams of CAVs and regular vehicles; travel behavior under CAVs and implications for shared mobility; transportation infrastructure design and planning for CAVs; CAV data collection, management, dissemination and safe-keeping; cybersecurity management of CAVs and infrastructure; and societal impacts of CAVs in terms of safety, efficiency, and environmental sustainability. A central feature of CCAT's approach is to test and demonstrate emerging technologies and concepts by leveraging the Ann Arbor Connected Vehicle Test Environment, a unique 'living laboratory' that has instrumented urban streets and highways, thousands of connected vehicles, motorcycles, bicycles, and smartphones; and Mcity, a state-of-the art off-roadway test facility for CAV testing and evaluation developed at the University of Michigan.

Let me give you one example of CCAT funded research projects titled "Connected Automated Vehicle Testing Scenario Design and Implementation Using

Naturalistic Driving Data and Augmented Reality". Testing and evaluation is a critical step in the development and deployment of CAVs, yet there is no systematic way to design representative scenarios for validating CAV systems. In this project, researchers investigated how to design representative testing scenarios for CAVs systematically by mining and examining crash and naturalistic driving databases. A small set of critical scenarios were chosen from the entire scenario space to generate the scenario library, by considering both the maneuver challenge and exposure frequency of the scenario occurring in the real-world. The proposed framework is theoretically proven to obtain accurate evaluation results with much fewer number of tests, compared with public road test methods. The results of the project can be used as a guideline to create a comprehensive testing scenario library; thus, increasing the body of knowledge and understanding amongst lawmakers and transportation professionals as they develop CAV testing regulations and standards. The automakers can also utilize the library to accelerate their CAV testing procedure to ensure the safety and efficiency necessary to make driverless technology viable. Ultimately, the project lays a foundation for generating a complete and comprehensive set of scenarios that can systematically evaluate the "intelligence" of CAVs. At the moment, the research results generated from this project are being integrated with the augmented reality testing environment and being deployed in Mcity.

The pace of CAV technology development is unprecedented. This is powered not only by the traditional transportation industry, such as automakers, but also by the investment put forward by the IT industry such as Google, Microsoft, Uber, etc. Advance transportation is a rising industry, and the need for a skilled workforce trained in these

new technologies is rapidly emerging. This need exists for technicians as well as engineers. Current curriculum in traditional transportation engineering programs, however, cannot meet the needs of the future workforce. Students must be equipped with modernized course offerings and hands-on training to accommodate new technologies and provide them with forward-looking technical skills.

In 2014, U-M has reestablished the transportation program in the Civil and Environmental Engineering Department. CCAT takes advantage of the newly established transportation engineering program in U-M's Civil and Environmental Engineering Department. Unlike most programs, this transportation program focuses on next-generation transportation systems. Surrounded by top-notch engineering programs at U-M and having access to industry partners involved with Mcity, the new transportation program, as it will be built from the ground up, has the potential to be an exemplary program that cultivates future transportation leaders and innovators equipped with the necessary skills.

CCAT has also assisted the Michigan Transportation Student Organization (MiTSO), which include the student chapters for ITE, ITS America, and WTS, etc., to grow with the aim of attracting more students to the field of connected and automated transportation. To this end, experts from industry, academia, and government have been invited to give talks at the student chapters. Moreover, CCAT has organized tours for the student chapters to Mcity, UMTRI, and auto manufacturers to provide students with field learning experiences. Activities like this attract attention from industrial and academic entities across the region, but also help to cultivate future leaders in this field.

CCAT provides graduate students with opportunities to advance their academic knowledge in the classroom and through participation on research teams. We have also provided travel awards to technical meetings and conferences such as the Transportation Research Board Annual Meeting so that students can present research findings, network with professionals, and learn from experts from around the world.

Another unique feature of the CCAT consortium is the inclusion of Washtenaw Community College (WCC) as a partner institution. Located in Ann Arbor, WCC is a leader in preparing technicians for advanced vehicle technologies. The college recently established the Advanced Transportation Center to address one of the most important challenges facing the national deployment of connected vehicle technologies: qualified, job-ready employees trained in the latest intelligent transportation systems. Located within a mile of the largest connected vehicle deployment test bed in the world, WCC faculty and students will benefit from the test sites, the experts and the technology that will play a part in transforming the current transportation system, as well as playing a critical role in the revitalization of the economy of the State of Michigan.

In addition, with the support of CCAT, WCC is developing a credentialing program for technicians to address the skills necessary to work within the rapidly advancing field of CATS. WCC will create a blended learning approach consisting of extensive online learning and resources coupled with campus-based sessions that highlight critical thinking and problem-solving related to real world case studies from industry based partners. WCC will also utilize engineering professionals to serve as project managers of students placed in embedded systems test engineering practicums and/or other experiential learning practicums. Course credit will be awarded for these

practicums. The university grant partners may also serve as internship hosts for student interns who wish to work on CAV related research projects.

CCAT consortium universities/colleges provide a full-spectrum of educational programs, ranging from non-credit incumbent worker training to upscale engineering-concentrated programs, from 2- and 4-year degree programs to advanced education. This extensive educational structure provides students in this region a complete spectrum of workforce education. Training the future workforce with the necessary skill set is critical to the regional economy concentrated within the auto industry.

Since 2017, we have held two global symposiums on CAV's, and are already planning another for 2020 (April 14-15). Our symposium brings together industry and academia to discuss the path towards a national deployment. We host a quarterly colloquium with students, academia and industry that dive into specific topics such as efficient freight movement, the state of our infrastructure, and smart communities. We believe that a truly smart livable, economically vibrant future is one with performance and resilience, vision and leadership and with a culture of service and inclusion – not just cars that drive themselves!

Recommendations for improvements to the UTC program

The UTC Program has provided funding to a wide variety of UTCs since the late 1980s. USDOT initiated the UTC Program in 1988 as authorized by the Surface Transportation and Uniform Relocation Assistance Act of 1987 to fund transportation curricula and research at universities nationwide. Since then, UTCs are awarded based on a competitive process following every transportation authorization. There are currently 37

UTCs collaborating with more than 120 universities throughout the country. In addition to federal funds, UTCs leverage funding from private, state, and local sources to conduct research, develop the workforce of tomorrow, and test innovations which make our transportation safer, more efficient, and more secure.

To better integrate technology transfer into the transportation research process, the UTCs are now required to develop Technology Transfer Plans (referred to as T2 Plans). The change from an optional to a mandatory T2 Plan for each UTC was a game changer and I believe that this will strengthen the UTCs' technology transfer efforts by making research results available to potential users. This will also stimulate more private investment that will extend UTC research projects.

In the 2016 UTC competition, the Department of Transportation received more than 200 highly qualified responses. As such, funding was not available for a significant number of applications which were deemed 'highly recommended' by the department's staff. To enhance innovation, expand workforce development, and leverage public private partnerships from UTCs, I recommend that the UTC program be fully reauthorized at no less than $150 million per year. Additional funding should be equally used to increase the investments made into UTCs, as well as to increase the number of 'national' and 'Tier-1' centers. The recommended increase is incumbent upon a much-needed increase in funding authorized as part of a FAST-Act reauthorization.

Additionally, I urge Congress to:

- Change match requirements to allow for Federal funds to be used as match, akin to other research programs.

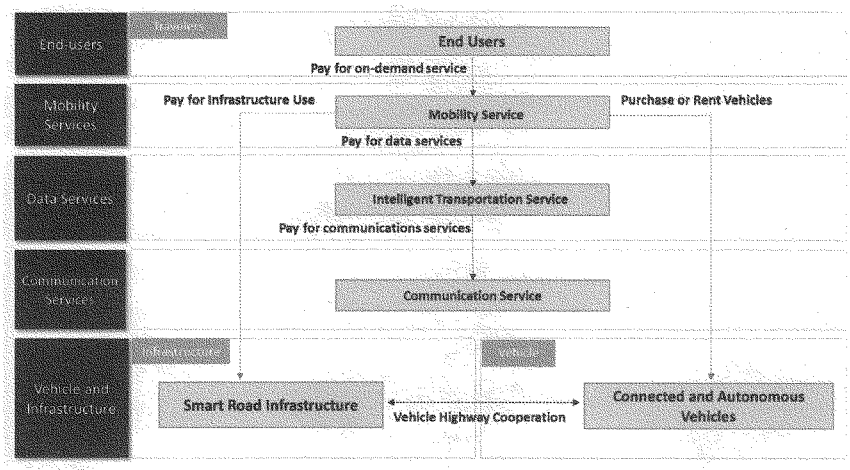
- Require submissions to include self-selected performance measures and metrics vs. all-encompassing metrics which are too broad to be useful.
- Creation of workforce development programs which utilize and leverage UTCs, including community colleges.
- Establish an annual open-unsolicited research program that UTCs can play a role in and submit projects ideas.

UTCs are where transportation innovation begins, and it is where we are training a transportation workforce for the 21st century. In order to ensure the US leadership in this wave of transportation revolution, it is more important than ever for Congress to reauthorize the UTC program with increased funding.

Needs and challenges for a national surface transportation research agenda

Before I describe the needs and challenges for a national surface transportation research agenda, let me offer my view on how the transportation systems will evolve in the future, as shown in the following figure. With the rapid development of communication, artificial intelligence, and cloud computing technologies, transportation systems are experiencing a revolutionary time because all three major elements of transportation systems are changing. End users are changing from owning a vehicle for transportation to using mobility as a service, vehicles are changing from human-driven to connected and automated, and road infrastructure are changing from static and independent from vehicles to digital and connected with vehicles. More importantly, transportation services are changing. Mobility services connect transportation demand and supply, communication services enable vehicle-to-vehicle communication and

vehicle-highway cooperation, and intelligent transportation services not only provide necessary information (including adverse traffic conditions, events, and potential crash objects, etc.) to vehicles, but also manage traffic flow so that both temporal and spatial resources can be allocated optimally. In short, our surface transportation system is becoming a complex social cyber-physical system that deserves extensive research involving not only scientists and engineers but also social, legal, and political experts.



Therefore, more research work needs to be done for a connected and automated transportation system and more support needs to be available. And we need a national transportation research agenda.

- We need to continue to invest in advanced technology development, particularly pre-competitive technologies that enable large scale CAV deployment, for example, testing and evaluation of CAVs, cyber-security, privacy protection, CAV traffic modeling and control, etc.

- We need to focus on infrastructure - beyond just fixing the roads and bridges, we need to deploy a connected infrastructure network that will accelerate vehicle automation.
- We need to better understand consequences of vehicle automation, such as affects on employment, social equity, and accessibility, even population distribution, property values, and other aspects of the economy.

The United States has led two waves of transportation revolution in the 20th Century. The first is in 1910s with Ford's massive production of Model-T cars that change people's concept on time and space, one can live in suburb and work in city center. The second is in 1950s with the construction of interstate highway systems that enable inter-city travel by car. The economic competitiveness so far achieved by the United States in the global marketplace is in no small part because it had led the last two waves of transportation evolution and developed the best transportation system in the world. The U.S. must lead the third wave of transportation revolution with connected and automated vehicle technologies, through further investment in research and development, in order to ensure international economic leadership.

University Transportation Centers, like the CCAT, are funded through the FAST Act. The FAST Act is critical to ensuring that the nation continues to recognize the added value of research, in infrastructure development and for the rapid deployment of these technologies across the nation and I look forward to continuing to work with the subcommittee as you work on the reauthorization of this important legislation.

Thank you again for the opportunity to testify today, and I am happy to answer any questions you may have.

Dr. Henry Liu is a Professor of Civil and Environmental Engineering at the University of Michigan, Ann Arbor, and a Research Professor at the University of Michigan Transportation Research Institute. He is also the Director of USDOT Midwest Region University Transportation Center, i.e., Center for Connected and Automated Transportation. Dr. Liu received his Ph.D. degree in Civil and Environmental Engineering from the University of Wisconsin at Madison in 2000 and his Bachelor degree in Automotive Engineering from Tsinghua University in 1993. Dr. Liu's research interests focus on transportation network monitoring, modeling, and control, as well as mobility and safety applications with connected and automated vehicles. On these topics, he has published more than 100 refereed journal articles. Dr. Liu is the managing editor of Journal of Intelligent Transportation Systems, and an associate editor of Transportation Research Part C, Network and Spatial Economics, and Transportmetrica Part B.

TESTIMONY OF DR. DARCY BULLOCK, DIRECTOR, JOINT TRANSPORTATION RESEARCH PROGRAM; AND LYLES FAMILY PROFESSOR, DEPARTMENT OF CIVIL ENGINEERING, PURDUE UNIVERSITY

Dr. BULLOCK. Chairwoman Stevens, Ranking Member Baird, and Members of the Committee, my name is Darcy Bullock. I am a Professor of Civil Engineering at Purdue University, and serve as the Director of the Joint Transportation Research Program. I appreciate the opportunity to share with you some of the recent transportation research implementation initiatives we have underway in Indiana, as well as my perspective on future opportunities. JTRP, as Ranking Member Baird indicated, is a partnership between INDOT (Indiana Department of Transportation) and Purdue. I'm going to talk about a couple recent projects that we've done, and then wrap up with what I think are some of the future opportunities.

The first one I just want to talk about is a project that I would argue is maybe low tech, but one of those high returns on SP&R projects, is—we partnered with the Indiana State Police, and we looked at what were the opportunities to improve the collection rate on invoicing insurance companies for damage to State property. And, as you see there, those are the net collection increase after we implemented that program. And Neil has been good—we just recently published this in TRB a couple years ago, and then this just got published in the most recent issue of TR News, and I'll put a couple plugs in for TRB, because I think it's a huge networking opportunity, but that's one of those forums that, as researchers, we share some of our implementation successes with.

The other one I want to talk about, and, actually, this involves Minnesota, Henry previously was at the University of Minnesota, so—has some ties to this is some work that we have done in the pooled-fund study process. It's a process that Federal highway has that States can get together and work on projects, and Ranking Member Baird alluded to that at the beginning of that. That has since gone on, and has been adopted by the Federal Highway Administration, Every Day Counts, EDC4, initiative, and is widely deployed. And that's one of those nice, organic initiatives where we pull together agencies, academics, and the private sector throughout the project to—so that it was implementation ready at the end.

And then the last comment, before I jump into future opportunities—public land grant universities—important for us to disseminate these results. We work hard to put all of these out, not only just in journal publications, but in terms of open access, downloads. That's a map of the downloads across the world. And I think I'm particularly proud of that distribution of commercial, academic, and government downloads. There's a fairly strong interest in its balance, and a strong interest in that commercial privatization.

So, looking forward, I would say that the simple tagline that I'd like to leave you with, and kind of—is that I believe our current vehicles know more about the infrastructure condition than we know as operating agencies. You know, for a long time, as civil engineers, we built the infrastructure, and the auto industry has built the cars. Henry has talked about this connected and autonomous

opportunity. It is right at the grasp of implementation, and I think, you know, just look out there. Our traditional feedback mechanisms are skid marks on the road, people calling in crash reports. If you think about, when your cars are—you're driving your cars, hard-braking events can be recorded. We already have accelerometers on those cars for airbags. If you drive a car that has lane departure warning on it, and you see where it can't see the lane lines, that is really good information to feed back to State DOTs.

More importantly, as we move to the connected and autonomous world, we've got 50 States out there, the auto industry's got eyes on all of that, so we've got to find some new ways to work on that. Reduced visibility signs, there's vegetation growing on the lower left corner, the cars are going to see that. Winter road conditions. We'd like to think our winter forecasts are perfect, but they're not, and so many times we wait for crashes to pile up. If we wait—if we can see the traction control and ABS (anti-lock braking system) kicking in, that would be incredibly important. So I guess my concluding comment is, if any of you are—when you're driving the car, and you see some of these indications coming in that are giving you feedback, and—man, wouldn't it be nice if we were providing that information to State DOTs? And I think that just sets the stage for how we can work together.

So, with that, I will just maybe make one concluding comment that fusing that probe data that we get, in terms of travel time and congestion that some of the previous speakers talked about, with our freight mobility map, is going to give us really strong insight into where we should make our strategic investments in capacity improvements, and perhaps intermodal facility. So, with that, I will conclude my remarks.

[The prepared statement of Dr. Bullock follows:]

Testimony of Darcy Bullock
Lyles Family Professor of Civil Engineering and Director Joint Transportation Research Program
Purdue University
to the
U.S. House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Research and Technology

"Bumper to Bumper: The Need for a National Surface Transportation Agenda"
July 11, 2019

Chairwoman Stevens, Ranking Member Baird, and Members of the Committee, my name is Darcy Bullock. I am a professor of civil engineering at Purdue University and serve as the director of the Joint Transportation Research Program (JTRP). I appreciate the opportunity to share with you some recent transportation research and implementation initiatives, as well as perspectives on future opportunities and challenges we face in developing a national surface transportation agenda.

Joint Transportation Research Program (JTRP)

JTRP is a partnership between Purdue University and Indiana Department of Transportation (INDOT) that dates to 1937. JTRP resides in Purdue University's Discovery Park, a collaborative research environment with a multi-disciplinary focus. JTRP's mission is to facilitate collaboration between public agencies, academia, and industry to implement innovations resulting in continuous improvement in planning, design, construction, operation, management and economic efficiency of our transportation infrastructure. The program generates innovative research and new knowledge to help solve current and future transportation challenges while improving efficiency and quality. To accomplish our mission, JTRP uses the collaboration model depicted in Figure 1. We currently have 60 faculty members, 170 grad students and 270 professionals involved in 84 active projects. Over our 82-year history, we have produced over 1,600 technical reports with over 4,200 co-authors.

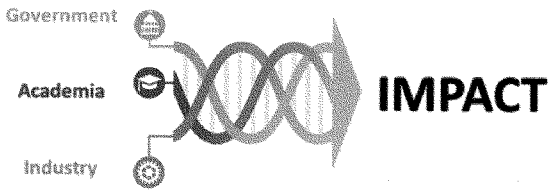


Figure 1: JTRP collaboration impact model for transportation research and innovation

When our research projects are initiated, stakeholders with subject area expertise participate as active members of the study committee to provide background knowledge and domain expertise that are critical to innovation. Of particular significance to Purdue, INDOT promotes careful and responsible use of their infrastructure (such as bridges, pavements, and signals) as "living laboratories" for research activities that cannot be duplicated in a university setting. INDOT staff are empowered by agency leadership to implement research leading to continuous improvement that allows them to do things cheaper, better, faster, safer. Private sector participation and input early in the research process leads to industry buy-in and is critical to implementation success. This integrated approach provides several benefits: 1) It involves government and industry stakeholders early in the research so that the team remains focused on implementable results; 2) The opportunity for students to directly engage with decision makers is a powerful motivating force with students; and 3) This sustained early engagement between stakeholders provides opportunities for field prototype implementations early in the research and informal professional development on emerging technologies within the partnering transportation agencies and private sector entities.

After projects are completed, INDOT identifies key performance measures and documents the impact of the JTRP research program. Finding out what does not work can be just as important as finding the solution to a problem. However, more often than not, the impact model produces deliverables that INDOT can implement. I would like to share two JTRP projects that have resulted in long-term, sustained impact due the collaboration of public agencies, academia, and industry. I will conclude with some thoughts on emerging opportunities for you to consider in shaping the next national surface transportation agenda.

DamageWise

Roadway infrastructure elements, such as guardrails, signs, and bridges, routinely sustain damage from motor vehicle crashes. In 2009, INDOT initiated a JTRP project to examine business processes related to repair of state property damaged by crashes. The research project involved extensive collaboration between relevant parties, including law enforcement agencies, INDOT maintenance departments, collection departments, and the insurance industry. The Purdue-INDOT research team recommendations resulted in initiation in 2011 of a statewide program called DamageWise and introduced a tagging system to be used by law enforcement when state property is damaged. This system allows INDOT maintenance teams to efficiently associate repair costs with a crash report so insurance companies can subsequently be invoiced for repair costs. (1)

INDOT's deployment and implementation of DamageWise required cross-cutting team participation from district maintenance crews and supervisors, central office finance personnel, information technology departments, as well as interagency partnerships with public safety and law enforcement colleagues. The direct involvement and establishment of performance measures by INDOT's Chief Financial Officer was critical to the success of this project. Figure 2 shows the annual collections realized from the DamageWise program, which went from $1.6 million prior to the program to $7.3 million in FY 2018 after full implementation. The on-going costs for DamageWise in FY 2018 were estimated to be $889,300. Adjusting the FY 2018 collections by the FY 2010 pre-DamageWise collections ($7.3 million versus $1.6 million) and applying the overhead costs ($889,300) resulted in a benefit-cost ratio of 6.4 for the DamageWise program in FY 2018. This program provides a recurring benefit to INDOT and the success of DamageWise was recently documented in the May-June 2019 publication of TR News, a publication of the Transportation Research Board (TRB). (2)

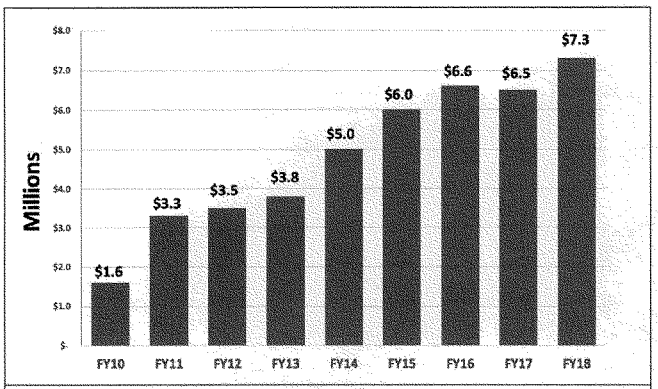


Figure 2: Annual collections from pre-DamageWise program (FY 2010) through full implementation

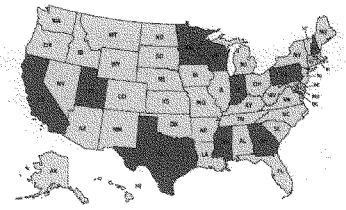
The key takeaways from this project are: 1) The implementation of DamageWise was relatively low tech, but success was dependent upon understanding the interface between public sector agencies and private sector insurance companies; 2) It required teamwork among a variety of diverse stakeholders ranging from public safety colleagues to INDOT maintenance staff; 3) The sustained multi-year tracking of DamageWise performance measures and recognition of stakeholder contributions is extremely valuable in the sustained growth and impact shown in Figure 2; and 4) It is important to share

these research successes on a national level, through venues such as TRB, so other agencies can learn about peer agency innovation and perhaps adopt as well.

Traffic Signal Performance Measures

As I indicated, INDOT is a strong advocate of partnering with universities and using their infrastructure as "living laboratories." INDOT's initiative to work with JTRP to develop instrumented intersections in 2005 provided the foundation for development of several public and private sector partnerships that led to the nationwide deployment of traffic signal performance measures. Purdue and INDOT started this effort by working with the traffic signal industry to develop a specification for logging traffic signal event data that could be retrieved via an Ethernet connection. This provided the research team access to event data for developing a series of performance measures that agency personnel could use to automatically evaluate quality of signal synchronization, efficient allocation of green time, identification of maintenance issues, and locations with high volume of red light running. Our early work resulted in attracting research funding from the National Cooperative Research Program (NCHRP) that provided increased national visibility.

However, as with many innovations, the private sector cannot effectively support 50 different state variations and we received feedback from the traffic signal community that it would be important to reach out to other states for input. In 2011, INDOT put together a Pooled Fund Study (PFS) solicitation that attracted investment from eleven states. More important than the financial investment however, was this cohort composed of Federal Highway Administration (FHWA) and eleven state DOTs coming together to collectively develop a common vision for data collection and performance measures that the traffic signal controller business partners could build. (Figure 3)



Map of PFS partner states

Project closeout workshop
Salt Lake City, Utah; January, 2016
with representation from 30 states

Figure 3: Pooled Fund Study 5(258) Traffic Signal Systems Operations and Management

Throughout this research, the team actively published over a dozen papers that were presented at the annual Transportation Research Board Meeting and published in the Transportation Research Record, most involving co-authors from either agencies and/or private sector partners. Five of those papers received best paper awards from a TRB committee. As a result of this government, academia and industry collaboration, as well as students joining agencies or private sector companies after graduation, Purdue traffic signal performance measures have been integrated into most new traffic signal control systems in the United States. Hundreds of local and state agencies use these performance measures and refer to them as the "Purdue Performance Measures." (3) (4) These performance measures were recognized by American Association of State Highway and Transportation Officials in 2013 as a focus technology and also by FHWA as a 2016 Every Day Counts Initiative that advocates accelerated implementation. (Figure 4)

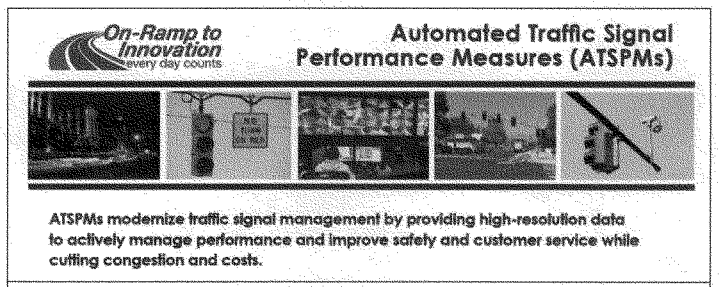
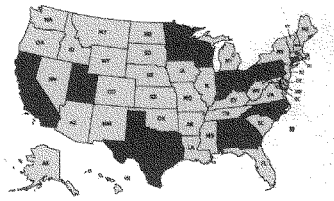
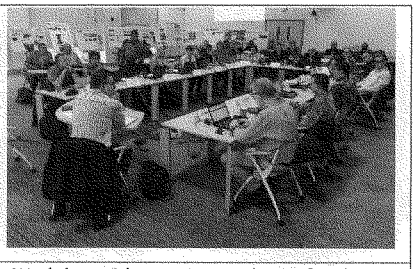


Figure 4: FHWA Every Day Counts 4 designation

Looking beyond performance measures that can be collected from roadway infrastructure, we have initiated a new PFS entitled "Enhanced Traffic Signal Performance Measures" to identify ways to integrate and leverage emerging connected vehicle data and provide improved traffic signal performance measures. The PFS includes representatives from 12 states, as well as partners from FHWA; College Station, TX; and West Lafayette, IN. Traffic signal vendor and auto manufacturer representatives are involved in this study focused on updates for the current Purdue Performance Measures and research to develop methodologies and tools for using high resolution vehicle probe data to compute traffic signal performance measures. Figure 5 shows the states involved with the PFS, as well as a picture from the PFS workshop on March 27-28, 2019, with representatives from state agencies, local agencies, traffic signal vendors, auto manufacturers, and academia. (Figure 5)



Map of PFS partner states



Workshop with agencies, academia, & industry
Purdue University; March, 2019

Figure 5: Pooled Fund Study TPF-5(377) Enhanced Traffic Signal Performance Measures

Open Access Dissemination Metrics

We place a high value on disseminating our results beyond traditional journals and are particularly interested in ensuring our publications are free and easy for public sector agencies to access. To promote knowledge sharing and increase impact, JTRP partnered with Purdue University Scholarly Publishing in 2011 to modernize report publishing and digitize previous reports. The JTRP technical report series contains 1,672 publications involving over 4,200 co-authors from academia, public agencies, and the private sector. To date, the JTRP technical research reports have been downloaded 1,777,673 times by 27,650 institutions representing 227 countries. Figure 6 shows the worldwide impact of this open access model. The JTRP technical report series is widely regarded as a best practice for rapid, cost effective dissemination to public agencies and other countries without requiring access to traditional academic journals, which often have costly fees. (5)

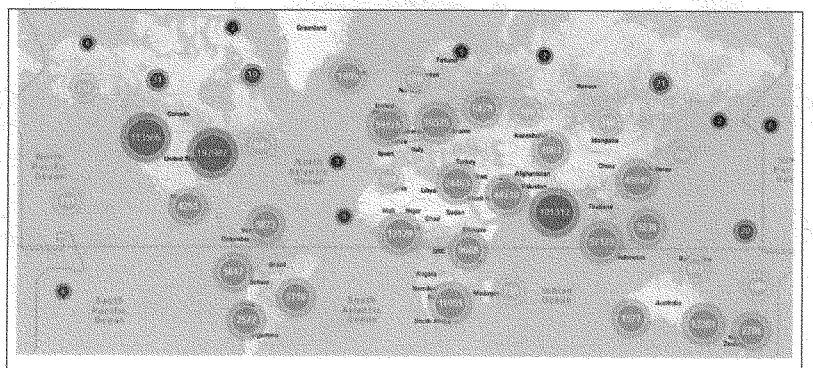


Figure 6: JTRP technical report download distribution as of July 4, 2019

Based upon the successful dissemination of research reports through the Purdue open access platform, JTRP began publishing additional series for conference proceedings, affiliated reports, posters, and monographs. Publications in the JTRP collection have been downloaded over 2.23 million times to date. The download count is dynamic, often with hundreds of downloads occurring daily within the collection. The distribution of the downloads in the JTRP collection among the commercial sector (40%), academia (44%) and government (16%) demonstrates the impact the research program has on the transportation community at large. (Figure 7)

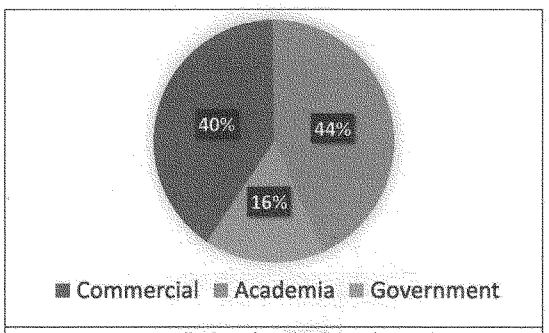


Figure 7: JTRP collection download distribution by sector
2,231,642 total downloads as of July 4, 2019

As I have indicated throughout this testimony, I believe successful research dissemination requires more than publishing reports. JTRP has a strong history of multi-faceted engagement activities to share information and best practices. We provide an annual legislative update to the Indiana Road and Transportation Committee. JTRP meets regularly with various stakeholders to solicit feedback on active transportation research and identify emerging issues. These stakeholders include private sector partners, public safety officials, associations of cities and towns, logistics associations, and other universities. Affiliated faculty make hundreds of presentations annually at technical conferences. These presentations amplify the impact of JTRP research and also stimulate additional publication downloads, as we frequently see surges in downloads after faculty presentations.

Engagement Activities

Beyond the tactical project-oriented interaction that occurs during the research process, JTRP and INDOT coordinate workshops and conferences to broadly disseminate innovation and best practices to the larger transportation community. One example is the Purdue Road School Transportation Conference and Expo, which had 3,015 participants attending over 150 sessions in 2019. The topics of

these sessions vary year to year and provide a forum for disseminating innovation and best practices to many INDOT partners, such as contractors, consultants and suppliers. Road School presentations are archived on the Purdue open access platform and have been downloaded 424,813 times to date, extending the impact of Road School well beyond the attendees.

Engagement activities also provide opportunities for academia, industry, and public agencies to interact with nationally recognized leaders in the transportation industry. For example, keynote speakers at the 2019 Road School included Brandye Hendrickson, Deputy Administrator Federal Highway Administration; Robert Martinez, Vice President Norfolk Southern; Jim Hackett, Chief Operating Officer Ford Motor Company; Tim Haak, Mayor of Zionsville, Indiana; Vanta Coda, Chief Executive Officer, Ports of Indiana; Chris Cotterill, Executive Vice President Indiana Development Corporation; and Joe McGuinness, Commissioner Indiana Department of Transportation. This engagement extends internationally as well. On March 27, 2019, Essam Sharaf, former Prime Minister of Egypt and Purdue student that worked on several JTRP projects (6) (7), attended the Traffic Signal Performance Measure Workshop and engaged with attendees from twelve state DOTs, industry, and Purdue faculty, staff and students.

Emerging Opportunities for Connected and Autonomous Vehicle Research: Vehicles often know more about the condition of our roadway infrastructure than we know.

As I have described earlier, INDOT partners with JTRP to develop long-term strategies for research, particularly related to adoption of new technologies and the transportation system's impact on economic development. In 2017, INDOT Commissioner Joe McGuinness made the following statement during Purdue Road School: "Autonomous, connected vehicles are a thing of the future, and the future is now. We have to start planning and making sure that we are prepared for what the automobile manufacturers are going to be putting on our roads." This statement is even more true today, as technology is evolving on a daily basis. In 2019, INDOT released a strategic plan that further emphasizes the need to enhance economic competitiveness and quality of life through increased understanding of Indiana's position as it relates to the autonomous/connected vehicle industry and initiatives to advance testing and research in the state. (8) The impact model employed by the JTRP program is critical to support INDOT's strategic initiatives. Obviously, Indiana is not unique. We are in a period where academia, public agencies, and the private sector must develop new partnerships to effectively deploy connected and autonomous transportation. A national agenda that promotes and facilitates this type of collaboration is essential.

Modern vehicles know more about infrastructure operations and condition than the transportation agencies operating the roadway system. For example, in 2012, the JTRP program proposed using crowd sourced data to develop nationwide performance measures, as shown in Figure 8. This graph depicts the 2012 monthly travel time deficit, normalized by length of Interstate in each state (hours/mile) for I-80 coast to coast. This performance metric can identify seasonal impacts of winter weather and summer construction, as well as congestion areas. Figure 9 shows the top 100 interstate segments, according to travel time deficit, that had the most severe congestion on I-80 in 2012. These types of performance metrics provide quantitative data to help understand the relative congestion along an entire interstate and can also be used to build consensus for capital investments on the interstate system, which ideally should be coordinated and prioritized on a national level. (9) In fact, the FHWA Everyday Counts Program (EDC5), identifies crowdsourced data as an important initiative and crowd source data will be an important research opportunity as we move forward.

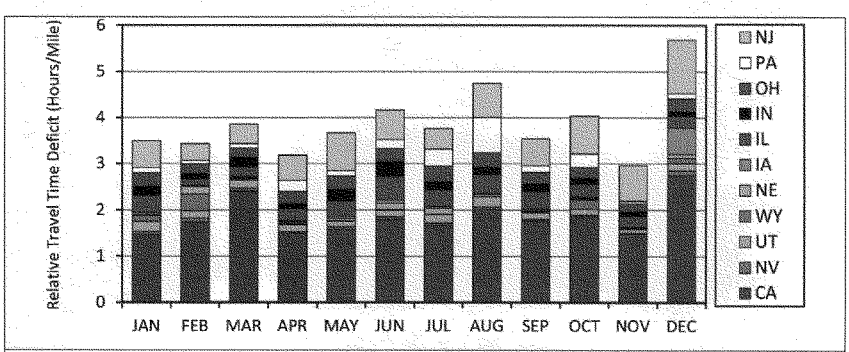


Figure 8: 2012 Monthly travel time deficit for I-80
Normalized by length of Interstate in the state (Hours/Mile)

Figure 9: Top 100 interstate segments on I-80 with highest travel time deficit (hours)

There are opportunities to further scale this crowd sourcing model. We still routinely identify maintenance and capital project needs using a combination of models, field observations of skid marks, telephone input from our users, and crash reports. (Figure 10) When one considers that most modern cars have a large collection of sensors that can provide this feedback, we must find ways to effectively and quickly share data between manufacturers and agencies in a manner that does not compromise privacy.

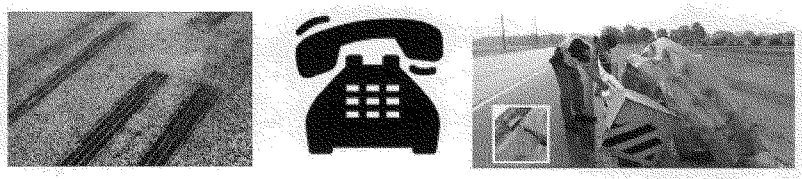


Figure 10: Traditional infrastructure feedback mechanisms need to evolve

As examples of emerging opportunities for transportation agencies to partner with the automotive industry, consider the following vehicle sensors and their ability to help us identify best practices and prioritize investments.

- Accelerometers used for air bags can also detect hard braking events to provide indications of "close calls" that are much better for identifying emerging hazards then waiting for skid marks or crashes to occur. (Figure 11) In fact, with the advent of anti-lock brakes, most modern vehicles don't generate observable skid marks which further increases the importance of partnering with the automotive industry to develop crowdsourced techniques to identify roadway locations that have abnormally high numbers of "close calls" for further engineering assessment.

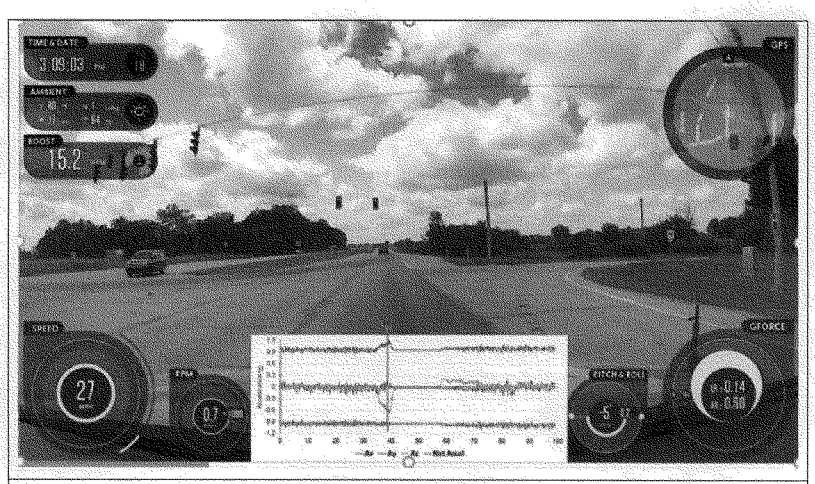


Figure 11: Hard braking event at signalized intersections (0.6g)

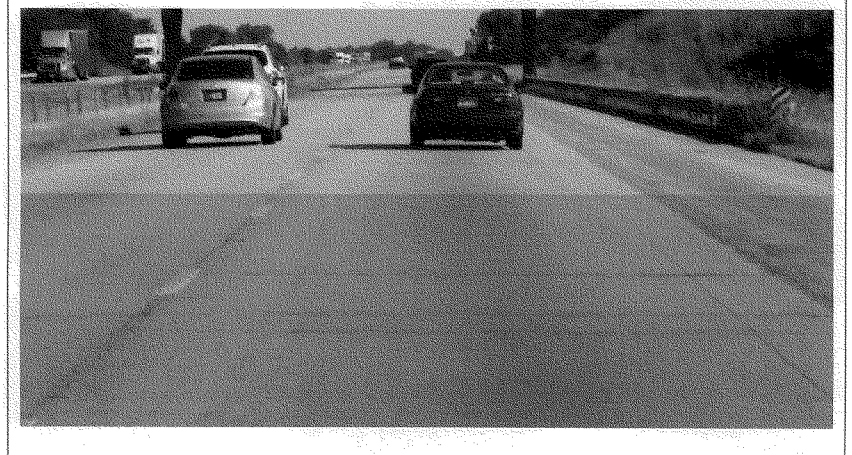
- Similarly, vehicle sensors associated with stability and ride quality can provide real-time mapping of emerging pot holes that can be used by agencies to prioritize maintenance activities, particularly in the spring when pot holes are rapidly emerging.
- Advance traction control systems, which allow vehicles to react to reduced friction during winter snow events, collect better real-time condition assessment of our roads then we can do with sparsely located sensors embedded in the pavement (10). Since many winter operations activities by agencies are based upon forecasts, this additional layer of vehicle data will provide more agile tactical allocation of plows and salt trucks during rapidly changing winter storms. (Figure 12)

Figure 12: Varying road conditions
due to drifting snow in rural area

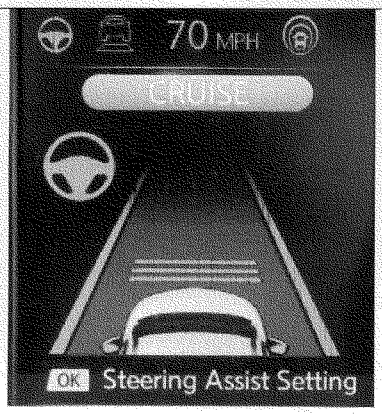
- Sign reading technology emerging on cars will provide us with the ability to identify locations where vegetation growth is reducing visibility. (Figure 13)

Figure 13: Example of vegetation growth
reducing visibility of sign on right side of road

- Lane departure warning systems, which currently provide feedback to drivers regarding lane position, also know when they can't "see" the lines or are confused by the lane markings. Given the diversity of pavement markings used across the country, systematically identifying these areas where lane departure warning systems are experiencing problems will help us rapidly converge on best practices and be better partners with the automotive industry. (Figure 14)



Roadway with worn pavement markings



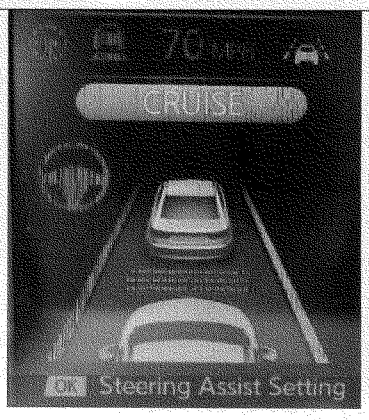


Figure 14: Example steering assist cockpit display on a road with worn pavement markings

In summary, I believe there are several near term opportunities for agencies, universities and the private sector to partner in sharing vehicle data in ways that protect the privacy of motorists and the intellectual property of automotive industry, while providing information that allows agencies to more effectively allocate scarce resources. Focusing on some of these near term benefits to agencies will also strengthen relationships and collaboration (Figure 1) that will be critical to the longer term deployment of autonomous vehicles.

Holistic Approach to Freight Movement

As many of you are aware, the Indiana state motto is "Crossroads of America." Our Governor has advocated that this is not just our motto, it is our mission. (11) Figure 15 shows a US Department of Transportation freight map and projections for 2040. As we look at the quantity and value of freight that is moved in this country (Table 1), we must continue to identify new opportunities for intermodal connectivity to not only improve our economic competitiveness, but also ensure our surface transportation system can effectively respond to future growth. When one looks at the top 100 congested sections of I-80 (Figure 9) and overlays that with state to state truck flow (Figure 15), it is not hard to envision how we can systematically and objectively prioritize infrastructure investments in highways, as well as multi-model facilities, that will be critical to sustained growth of domestic commerce.

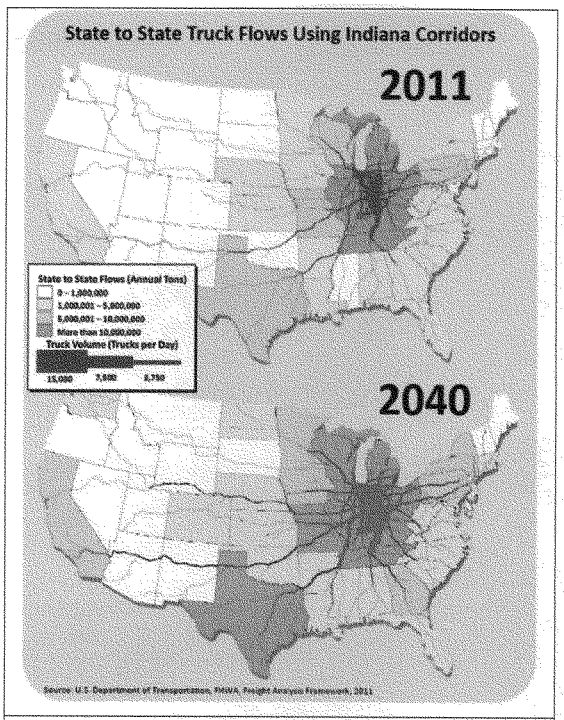


Figure 15: State to state truck flows using Indiana corridors

Table 1: Weight and Value of Freight Shipments by Domestic Mode: 2017		
Domestic Mode	Tons	Dollars
Truck	11,520,318,384	$12,421,510,923,492
Rail	1,738,345,508	$690,458,559,600
Water	766,322,366	$363,500,106,900
Air (including truck-air)	5,871,207	$591,253,478,699
Multiple modes and mail	495,680,450	$2,328,112,103,999
Pipeline	3,049,856,604	$942,007,459,500
Other and unknown	39,210,395	$97,632,790,600
No domestic mode	208,676,316	$66,410,035,300
Total (All modes)	17,824,281,230	$17,500,885,458,090
SOURCE: U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.5, 2019.		

Concluding Remarks

- We are very proud of our 82-year partnership between Purdue University and Indiana Department of Transportation (INDOT) through the Joint Transportation Research Program (JTRP). Not only have our research results been implemented at a state and national level, students who have participated in JTRP research projects have gone on to hold senior leadership roles at transportation agencies, private sector companies, and even lead other countries.
- Universities can play a critical role in the collaboration between transportation agencies and the private sector (Figure 1). The emerging area of connected and autonomous vehicles is particularly ripe for this collaboration model.
- A national surface transportation agenda should encourage collaboration among state agencies to help ensure that we are not creating 50 different solutions to the same problem. The current FHWA Pooled Fund Study mechanism is one of many important programs for incorporating perspectives from diverse states, while providing a mechanism to develop a consistent message for industry partners.
- Freight movement is critical to our nation's economy. Collaboration across all modes of transportation is essential to help ensure that we are moving freight in the appropriate mode that increases efficiency, improves safety, addresses environmental issues, and promotes economic competitiveness. I believe some of the emerging crowdsourcing transportation performance measures will be important tools to help us identify opportunities for further improving our nation's freight movement across all modes.

Finally, I would like to thank you for inviting me to engage with your committee. As I indicated earlier, I place a high value on identifying opportunities for our students and faculty to engage with both Industry and government officials. If any of you are interested in further dialog on some of the topics discussed today, I would welcome follow-up communication and the opportunity to host you in Indiana for further dialog with our students, faculty, and industry partners who are the foundation of our Joint Transportation Research Program. (Figure 1)

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Dr. Darcy Bullock is a Professor of Civil Engineering at Purdue University and serves as the director of the Joint Transportation Research Program (JTRP). Bullock is a Registered Professional Engineer in Indiana and has 30 years of experience in the industry working closely with vendors, state agencies, USDOT, and colleagues at other universities. Bullock's teaching, research and consulting interests have been in the general area of traffic engineering. He received a B.S. in Civil Engineering from the University of Vermont, and a M.S. and a Ph.D. in Civil Engineering from Carnegie Mellon University. Bullock has served in leadership roles with a variety of professional organizations including the American Society of Civil Engineers (ASCE), the Transportation Research Board (TRB), and the Institute of Transportation Engineers (ITE).

Over the past two decades, Bullock has completed several projects with the Federal Highway Administration, Federal Aviation Administration, National Cooperative Highway Research Program, National Science Foundation, Department of Homeland Security, Houston Airport System (Houston Intercontinental Airport), Kenton County Airport Board (Cincinnati Airport), Volkswagen, and Ford Motor Company, as well several state and local transportation agencies. The results of those projects are published in over 350 journal articles, conference proceedings, and technical reports, several of which have received national awards from American Society of Civil Engineers (ASCE), Transportation Research Board (TRB) and Institute of Transportation Engineers (ITE). The impact of his research projects and the JTRP program on the state of Indiana has been recognized by the past three Indiana Governors.

Chairwoman STEVENS. Well, at this point we're going to begin our first round of questions, and the Chair is going to recognize herself for 5 minutes.

Our hearing, "Bumper to Bumper: The Need for a National Surface Transportation Research Agenda," poses the question how do we actually catalyze a national surface transportation research agenda? How are we catalyzing that? By dialoguing, and hearing from you, who are on the ground, who are managing departments, who represent the intersection of research at the university level to the States, or regional agencies, which you happen to represent.

I think the history is important, and if I can indulge Michigan for just another bit here, my State, the State that bore the automobile, the State that, you know, the first mile of concrete highway was created in 1909. 1912, the Nation's first highway materials testing lab at the University of Michigan. 1918, the traffic light. 1923, the Nation's first superhighway. 1942, the Nation's first depressed urban expressway. 1960, the Nation's first State to complete a border to border interstate, I-94, running 205 miles from Detroit to New Buffalo. 1977, the Nation's first—this is a good one—the Nation's first bicycle path to be constructed alongside an interstate freeway.

This was innovation in action as our country was catalyzing 21st-century capitalism through our industrial might. We have somehow accepted stagnation. We've accepted underinvestment. And, Dr. Bullock, I want to pick up where you left off, because I came to Congress out of an IOT research lab, and I think the IOT, the Internet of Things, the mobility, the interconnectedness of data, and the partners that we are leaving out here, are really important to hone in on.

So what you had just said about our cars knowing more about our roadways than we do, is there something that we could do with automotive and the companies? Is there a partnership? Where are they in the conversation, and how can we fix that?

Dr. BULLOCK. [no audio]. Automotive industry, and the public agencies, are starting to realize, I would say. We are aggressively working right now, as the State of Indiana, to engage with them. For the last 5 years the Indiana Department of Transportation buys 1-minute real-time probe data that gives us the speed performance on our interstate. But that's not enough. We're not happy with that. We want to know where are the potholes? We want to know where the hard-braking events are. We want to know where are the traction-control events? Where are we not seeing the lines? So I think we have got to now start articulating those use cases so that then we can frame those in a way that doesn't compromise privacy, but then provides an improved data set so we can make more informed decisions.

Chairwoman STEVENS. They want to know as well. The auto companies want to know. I mean, they are pushing this vision of hypermobility and interconnectedness. Dr. Liu, it begs the question from kind of your standpoint on research out of the University Transportation Centers, moving federally funded research into practice, how do we do this tech transfer? How do we continue to catalyze tech transfer activities, or have they increased since the

FAST Act was enacted? Anything you can shed light on there for us?

Dr. LIU. Yes. I think there's a lot we can do, and at the university we are the best to conduct research on fundamental research, and we also do applied research. And to continue your Michigan first, the Mcity is the first test track for connected automated vehicles in the world, and that's in 2015. This goes into the 21st century.

So this is actually one of the examples that capitalize on university research, and lead the way for implementation and deployment of connected automated vehicles. So at—every university has this technology transfer office, and we work with myself, but we also work with the technology transfer office to license our technology to the industry.

So I think to—at the university, I think we want to do fundamental research, high-risk, high-reward, and then we have an established mechanism to convert this research—transfer—transform this research into the practice.

Chairwoman STEVENS. Thank you. Thank you very much. And with that Dr. Baird was joking around that I was only going to use 3 minutes of my time, but I'm using all of it, and now I'm going to pass it over to him. I'm going to recognize him for his 5 minutes of questioning.

Mr. BAIRD. Thank you, Madam Chairwoman. And, Dr. Bullock, I'm going to give you the opportunity to boiler up and help me counter all of this Michigan first stuff, if you will. Anyway, my question really deals with having you elaborate maybe on this Joint Transportation Research Program, and how that partnership between Purdue and the Indiana Department of Transportation works, and how's this program performance evaluated, in your opinion? Because I'm going to have some additional questions to that, how does the collaboration offer greater opportunity, and how important such collaboration can be to bring and address the emerging area of connect and autonomous vehicles. So pick out any one of those questions you'd like and elaborate, and especially those that are first over Michigan, if you will.

Dr. BULLOCK. Well, I don't know. I think there's an immense amount of collaboration with the Joint Transportation Research Program, whether it be within Indiana, or with peer States. And so the Joint Transportation Research Program is our vehicle that we use for managing the SPR research funds. And I say joint because this—we go back 82 years, and, you know, I'm—we're building on the success of my predecessors. They've established strong dialog between Purdue University and INDOT on two levels. I think we're very tightly engaged with not only the executive staff, but the folks that are doing the work. And sometimes it's the folks running the pothole patching, sometimes it's the engineers, sometimes it's the policy, sometimes it's the Commissioner. And so that joint part is critical. I think that they facilitate teamwork.

In terms of evaluation, I was proud—I think it was—Mr. Ness referred to some of the return on investment. Probably for the last 10 or 15 years, our executive staff has put a lot of pressure on us, good pressure, to demonstrate return on investment. I will tell you we are not 100 percent successful in all of our projects, and so, as

he pointed out, there's a few winners that have some significant returns, but sometimes we learn the projects that don't work, and what doesn't work, sometimes learning not to do that is just as important as learning what to do. So I hope I've given you a reasonable, succinct description of a couple of those points.

Dr. LIU. I just want to mention one thing. The Center for Connected Automated Transportation has Purdue also as a member institution, so it's not a competition. It's a collaboration.

Mr. NESS. And I would not—Representative, yes, I would not leave Tri-State University, from the fine State of Indiana, that helped springboard my education in that discussion either. But I'd also like to address that you cannot always have a positive return on investment. I agree that we learn a lot when maybe something doesn't work, so we know what not to do, and there's a lot of research that's done on behavioral-type activities, when you're driving, and how you behave behind the wheel. How does that research help drive down deaths on the highway? And how do you measure that, how much did that contribute? You may not always get that positive return on investment.

However, I think, as you make the tough decisions as—how you distribute tax dollars across the country into various programs, you have to understand that a good research program can provide significant returns on investments. And if you can invest in new materials and innovative products, then you're able to spread your dollars that you have for construction that much further.

Mr. HENKEL. I might add that the committee, as we looked at the Federal programs, including the ITS JPO, found that these programs are designed to serve the States and local governments that own and operate the highways, and must deploy innovations to ensure these highways serve the interest of society and the economy. Our report notes that more than 80 percent of the FHWA's HRD—RD&T activities identify State DOTs as partners, so it's important to continue that partnership, as demonstrated by FHWA, and the programs that they implement today.

Mr. BAIRD. Thank you, and my time is up, and I yield back, Madam Chair.

Chairwoman STEVENS. Thank you. And now I'd like to turn 5 minutes of questioning over to Dr. Lipinski, who is an expert in this field, and I imagine is going to ask some really great questions.

Mr. LIPINSKI. Boy, that's a lot of pressure you're putting on me now. I want to thank the Chairwoman for holding this hearing, and thank the witnesses for their testimony. Chairwoman is correct in that I have done a lot of work in the area of connected autonomous vehicles, work in terms of work here in Congress, in trying to get us on a good path when it comes to research, and getting these cars on the road, seeing what the Federal Government can do. In the *FAST Act* I was able to get provisions in there on connected autonomous vehicles, including—University Transportation Center focused on the technology, a new interagency policy working group at the DOT to promote the development of autonomous connected vehicles, and a GAO (Government Accountability Office) study of connected autonomous vehicle policy.

So I wanted to ask Dr. Liu, where are we now in this regard, and what can we here in Congress be doing? I sit both on this Committee and also on the Transportation and Infrastructure Committee. What should we be doing in Congress to really promote better research, more research, and what we can do to get autonomous and connected vehicles, you know, out there on the road, and all the benefits? You know, we want to make sure they're safe. There are a great number of benefits that can come from autonomous connected vehicles, so what should we be doing going forward?

Dr. LIU. I should say we are at the starting point of this transportation evolution with connected automated vehicles, so we have a long way to go. We need not only science and engineers, but also political, legal, and social experts. So—this connected automated vehicle technology is going to change the society. As I mentioned, this may have implications in terms of employment, even population distribution, and other aspects of the economy. So there—a lot of research needs to be done, and—not only on the technology development, but also on the consequences related with vehicle automation.

So in terms of research, I think we need to focus on, first of all, the technology development. There are a lot of technology that need to develop, and—because we have not really solved the issues related with safe and efficient deployment of connected automated vehicles. For example, we know how we test a regular human-driven vehicle, in terms of the safety standard. We don't really know how to test a connected automated vehicle in terms of—yet, how to test the intelligence of an autonomous vehicle. That's still an open question. And that's the pre-competitive research I mentioned in my testimony. We need to work on those.

The second thing I would say, infrastructure is very, very important. Connected automated vehicles, they can't really just rely upon their own sensors. They need to have help coming from the infrastructure. A connected infrastructure network will accelerate the vehicle automation, in terms of their deployment. So connectivity on our infrastructure is the key also for the large-scale deployment. So all these issues we need to work on, and we need to—these—the issues, once it's resolved, will help us to accelerate the deployment of this connected automated vehicle technology.

I do want to say that this is—although this is at the starting point of this technology, there is a lot of interest, and it is a hot topic not only in the U.S., but around the world. So to ensure U.S. leadership on connected automated vehicle technology, we need to increase our funding support on these issues.

Mr. LIPINSKI. Thank you. And I want to add I think it's very important that, on this Committee, on this Subcommittee, that we take our role in the reauthorization of the *FAST Act* very seriously, and we take a lead in the research side of that bill. So I want to emphasize that, and those issues that you raised, Dr. Liu, are very critical, and we need to make sure we are not only looking on those, but acting on those. I'm afraid that we move too slowly here, and we need to make sure that we do everything that we can to make sure we are not slowing down the research in the advancement of connected autonomous vehicles here in our country. And

we want our country to be the leader in the world on this really transformative technology, so thank you. Yield back.

Chairwoman STEVENS. The Chair now recognizes Mr. Balderson for 5 minutes of questioning.

Mr. BALDERSON. Thank you, Chairwoman Stevens, and I want to thank you and Ranking Member Baird for inviting, I won't kid around, two Big Ten universities for the hearing today, but you left the best one out, and that would be the one that I represent. I'm sorry, Dr. Liu, but that would be Ohio State University, thank you all for being here today, and I appreciate your input on this. And I, like Representative Lipinski, sit on the Transportation and Infrastructure Committee, so thank you, Chairwoman Stevens, for putting this together.

My first question will be for Dr. Liu and Dr. Bullock. Last Congress I sent a letter supporting Ohio State University's application to be a UTC, focusing on the congestion relief. The centers at both Purdue and Michigan are researching ways to improve our Nation's highways and byways. These centers are crucial parts of the transportation and research world. Could each of you discuss the expected impacts of expanding the number and role of the UTCs in the next surface transportation reauthorization? And, Dr. Liu, you may go first.

Dr. LIU. In my written testimony, I mention that in the last funding competition, the USDOT received more than 200 highly qualified proposals, and we can only fund 37 of those. So a lot of highly qualified proposals were declined, and yet we have lots of questions—open questions, particularly in transportation evolution area. So I—in my—also in my written testimony, I mentioned that I urged the Congress to double the funding for UTCs because we have many qualified—university qualified researchers to do—work—research work, so that can accelerate the deployment of the connected automated vehicle technology. So I think we are at the stage that we urge the Congress to reauthorize the UTC with increased funding.

Dr. BULLOCK. So I would agree with Henry that increased funding in the UTC is important, and I would suggest—based on what I presented earlier, one of the near-term opportunities I see is, if we can have some—I would say challenge the universities and the auto companies to work together. And I listed five, and there might be more, but give us a way to, while protecting privacy, see where the potholes, see where the hard braking, see where the obscure pavement markings, see where the obscured signs are, see where those winter markings are. The advantage of doing—getting the auto companies involved early is that is a nice, scalable approach. We've got some immediate returns to the State DOTs, and it will establish some fundamental building blocks that will serve us well for this connected and autonomous world.

Mr. BALDERSON. OK. Thank you both very much. In the time remaining I have, I have one more question. Dr. Ness, many States are attempting to subdue the effects of crumbling infrastructure on their own. Noting Federal support is often lacking, as has been mentioned on this Committee today, as a Member of the Transportation and Infrastructure Committee, I have worked closely with Transportation on its priorities for the upcoming Surface Transpor-

tation reauthorization. Can you provide examples of some commonsense reforms that are important to your State that you would like to see as the House prepares for this transportation bill? Specifically in terms of research—but feel free to expand outside whenever you feel.

Mr. NESS. Yes, Representative, I believe that some of the regulatory reforms that have already been started go a long ways to helping us stretch our dollars. The more flexibility that we have as States, the better we are to make decisions that are specific to transportation in our area. I would also highlight too, the fact that not only just the regulatory reform, but just the flexibility that we could have in funding, and to keep formula funding, keep the existing formula in place so we're able to make those decisions. But I think that's the biggest thing that I would promote, is allowing us to make decisions at that State level.

Mr. BALDERSON. Thank you very much. Madam Chair, I yield back my remaining time.

Chairwoman STEVENS. Thank you, Mr. Balderson. At this time the Chair would like to recognize Mr. Tonko for 5 minutes of questioning.

Mr. TONKO. Thank you, Chairwoman, and thank you to our Ranking Member also the two of you for hosting this hearing, which I think is very valuable, and welcome to our witnesses. As an engineer, I recognize that improving our transportation system is key to improving daily life for Americans, and creating long-term economic growth across New York State, my home State, and our country. I am an especially strong supporter of investing in rail, since it is an extremely energy-efficient way to move goods, while also being environmentally friendly. As a Nation, we need to look at all the pieces involved in surface transportation, and examine how we can increase efficiency and reliability, reduce congestion, and, in turn, reduce emissions.

One way we will accomplish this objective, I believe, is through federally funded research and partnerships. For example, freight transportation is critical to the economic vitality of the United States, and has a huge footprint in the district that I represent, in the capital region of New York. Throughout Upstate New York there is an incredible bit of research happening on this subject. In New York's 20th District, which I proudly represent, RPI's (Rensselaer Polytechnic Institute's) Center for Infrastructure, Transportation, and Environment is conducting research on this subject in collaboration, and with funding, with DOE (Department of Energy) and DOT. Professor Holguin-Veras, who leads this research, has shared that freight transportation and delivery, is at the crossroads where several challenges collide. It has significant impact on our economy, it produces large amounts of CO_2 emissions, it creates traffic congestion and gridlock, and can come with high cost to producers, deliverers and consumers. So RPI's research examines how changing the behavior supply chains could reduce energy consumption.

Through a project in New York City, the team at RPI found that simply delivering goods overnight, instead of during daytime traffic, reduced a truck's emissions by an estimated factor of some 65 percent. They found that off-hour deliveries can also reduce the

cost of transporting freight by some 45 percent. So my question to all of our witnesses is the following. Are DOE and DOT and other agency investments in freight optimization producing worthwhile results, like the significant reductions illustrated here, and should we provide more funding for freight-optimization research? Anyone?

Mr. HENKEL. I'll start.

Mr. TONKO. Thank you, Mr. Henkel.

Mr. HENKEL. The RTCC (Research and Technology Coordinating Committee) looked at this issue from the perspective of Congress' criteria, as well as the critical issues report that was generated recently by TRB. As we looked across the criteria, we found that the Federal program was sound in meeting the requirements that Congress put forward and established to ensure that the research ongoing was meeting your requirements. Part of the research that is ongoing is in the freight area. The RTCC also looked at examples of additional research that could be funded, if additional funding were made available, using the critical report, and found that one of the areas does confirm, Congressman, that the freight area is a need.

In fact, the report specifically says that models and data collection is one of the areas that would be a need in the freight area. It suggests that better estimates for potential for freight mode shift, while considering expansion of the interstate and inner city highways, is a potential area for focus.

Mr. TONKO. Thank you, Mr. Henkel. Solutions require us to work together in public-private collaborations. That should include our cities and our local communities, the private sector, the government, and certainly research universities. In particular I strongly support increased funding to the university transportation programs. Dr. Liu, you noted that in the 2016 UTC competition more than 200 highly qualified responses were received, and funding was not available for a significant number of these highly qualified applications. Would you please explain more? Why is the UTC program worthy of increased investment?

Dr. LIU. The research—I think the research universities are the fundamental pillar, in terms of our scientific advance in transportation research. So the UTCs is also where the transportation innovations really begins. It's also where we educate our next-generation of working—workforces. So that's why I think, although the current UTC involves 120 universities, and I think it will be good to increase the funding, to increase the number of the UTCs and—so that more research can be done, and more work—future workforce can be educated.

Mr. TONKO. Thank you. Thank you, Dr. Liu, and with that, Chairwoman Stevens, I yield back.

Chairwoman STEVENS. Thank you. And now the Chair will recognize Mr. McAdams for 5 minutes of questioning. Thank you.

Mr. MCADAMS. Thank you, Chair Stevens, and Ranking Member Baird, for holding this vital hearing. I think about the implementation of the previous surface transportation bill, the *2015 FAST Act*, and the ways that we can work collaboratively to produce the next important legislation that will shape the future of transportation. So I come from the State of Utah. Utah is the fastest-growing State in the country, and the bulk of that growth is in the Salt Lake and

Utah valleys, so thinking creatively and collaboratively about what our transportation future looks like is imperative to the success of that growth.

Part of the success that Utah has seen already is because of the cooperative participation with Federal, State, regional groups, our NPOs, and local transportation agencies, but also collaboration across modes of transportation. Our DOT, and DOT director, works very well with our transit authority, and—so that, I think is important. And then one of the things that I think is important that we're seeking to implement is to make sure that those decisions are also done in connection with land use decisions, and land use planning. So are moving toward a framework that we call Access to Opportunity. Rather than just looking at investing in transportation for transportation's sake, we're recognizing what we're trying to do is to connect individuals to opportunity. Sometimes that is improvements in transportation, sometimes it's designating land use, so we would bring the jobs closer to where the people are, or where the recreation opportunities to where the people are, or the housing close to where the jobs are.

So I'd love—just a couple of questions. If any of you on the panel, but particularly Mr. Ness from—Western State, like my neighbor to the north of us, if you could give me an example of how the *FAST Act* provides a model for success when it comes to collaboration between your State agency and other partners, and then also across modes of transportation?

Mr. NESS. I think to be successful you have to look across all modes of transportation, you have to partner with those at all levels. And—particularly when you think about the research program, and I highlighted in my remarks the need for a multi-tiered research program. And that way it isn't one group, or one person having the say in how we spend our research dollars. Just like, through the *FAST Act*, it isn't one group, the Federal Government, or the State, or the local, saying, here's how we're going to spend our money. It is a collaborative effort, and all modes of transportation are interconnected, and it's about getting people and goods from point A to point B. And, for example, that may involve taking my car to the airport, flying to Washington, D.C., taking a train to get to where I need to go, or even walking to where I need to be from—once I get settled in my hotel. So I think everything's interconnected. Certainly the more collaboration you have, the better decisions you can make, because you have more data in order to make those decisions, based on that input.

Mr. MCADAMS. And I might add, I think it's even when you take it down to the local level that's—taking a bike share to the transit stop, or, you know, the—to get it to connect to a car, or—multimodal even at the very local level, from pedestrian, to bicycle, to transit, to road, and all of that, I think, is important.

I'm interested, for the panelists, if there are ways that we can improve collaboration the next time around between our Federal and State local partners. One of the challenges that I saw in my previous role, I was a county executive, Mayor of Salt Lake County, and sometimes those funding streams are fairly rigid. There's funding for roads, there's funding for transit.

And so, as we try to think more comprehensively, just connecting people to opportunities, and the funding streams aren't as maybe fluid as we want to think in our land use planning and transportation planning, are there ways that we can further improve collaboration between Federal and State partners, and also across modes of transportation, and also to make sure that our transportation investments from the Federal level better align with local land use decisions?

Mr. NESS. I'll—Representative, I'll address the one about collaboration. And I found in my department that when you have shared performance goals, then you have a vested interest in the entire team trying to make that work, instead of individual performance goals. And I've suggested to the Federal Highway Administration that, for the States to be successful, Federal Highway Administration has to be successful, and vice versa, so, therefore, the goals of the Federal Highway Administration should be the same as those—as the States that are implementing their program.

Mr. MCADAMS. Thank you. And it looks like I'm about out of time, but I just want to lay the marker down that the other piece that I'm interested in the reauthorization is—we obviously need strong environmental regulation review, but how can the next surface transportation bill work to streamline permitting, and ease the regulatory approval process to meet our transportation needs? Are there areas where this regulatory approval process is duplicative? And that costs money and time to our State and local partners. So, with that, I'm out of time. Madam Chair, if maybe you'll take a couple of seconds, if you will?

Mr. NESS. I'll be very——

Mr. MCADAMS. OK.

Mr. NESS [continuing]. Quick on that, and I think sometimes it's a series of processes. This one starts, and when it finishes, the next one starts, and I think we can do that more in parallel.

Mr. MCADAMS. That's an issue that we were trying to—I know that we tried to address the last time around, and that it was very frustrating to me at the local level too, is this sequential approval process, sometimes approvals that were inconsistent with each other, and it just cost time, and money, and frustration at the local level. Thank you, and, Madam Chair, I yield back.

Chairwoman STEVENS. We're always happy to grant a little extra time to a mayor——

Mr. MCADAMS. All right.

Chairwoman STEVENS [continuing]. Who happens to now serve in Congress. And, with that, the Chair would now like to recognize Ms. Sherrill for 5 minutes of questioning.

Ms. SHERRILL. Thank you. The Gateway Tunnel Project is one of the most important infrastructure projects in the Nation, as you may know. It's updating the two over 100-year-old Hudson Rail tunnels that in and out of Manhattan from North Jersey. Those tunnels were damaged in Superstorm Sandy. And so it involves rails, and bridge projects, and includes refurbishment of a deteriorating tunnel, and it provides the only direct train connection between New Jersey and Manhattan. It's a critical link for Amtrak's Northeast Corridor, connecting 8 States and Washington, D.C., and it services routes throughout 20 States. So failure of this railway

would be catastrophic for the region, but recently the Department of Transportation has given the project a medium-low rating, disqualifying it for funding from its Capital Investment Grant Program. And so I was wondering if you could speak to, how the Department of Transportation incorporates Federal research into evaluating the importance of projects, and assigning ratings to national transportation projects? That's to all of you.

Mr. NESS. Representative, I will go back to my initial opening remarks, where I said, at least from an AASHTO perspective, on our Research and Innovation Committee, we have four vision goals that we want to accomplish. One is that there is that strategic approach, and, on that strategic approach, one of those ways is to look at the 12 critical issues developed by the Transportation Research Board for transportation. The second is, when possible, these—that project should have a positive return on investment. That research, we need to translate that into real results in the field, and that we accelerate those timeframes because the technology is moving faster than the research now. So I'll come back to that as—when we prioritize research projects from the States' perspective through AASHTO, those are the guiding principles that we use.

Ms. SHERRILL. So I couldn't agree more that, you know, Federal agencies have to be good stewards of the taxpayer dollars, and making infrastructure investments, we need to make sure we're getting a good return on our investment. And so the Gateway Tunnel Project, again, is unique among service transportation projects in its complexity, its cost, and the vast numbers of travelers counting on it. It's only a matter of time until the current tunnels suffer from a failure that would significantly harm our entire country's economy.

So as we look at infrastructure project scenarios, like New Jersey and New York, that may carry a high price tag, but will have a high rate of return, when you consider that region to be one of the most highly populous and highly productive metropolitan areas in the country, can you tell me, what research do your institutions or agencies engage in to help assess the value, and help us understand how we can maximize our Federal research investments? And I hate to keep Mr. Ness on the hot seat. Does anyone have any thoughts on how we assess our investments into our infrastructure? Mr. Ness, since you seem to be——

Mr. NESS. I think it's just a matter of—obviously, across the country, there's less resources than there are needs out there, so you have to determine what are your priorities, where do you target your investments. And, again, I come back to where do we get our greatest return on the dollar, where do we provide the greatest economic opportunities by investing in transportation in an area. They're not easy decisions to make, that—you have to balance—and I think there has to be some geographic balance, because there's needs all across my State in Idaho, and certainly across the country. So I also think we need to think of our transportation investments in a nationwide type program.

And, for example, if you enjoy a baked potato with your steak, or whatever you eat at dinner, certainly you want to make sure that we can get that baked potato—or that potato from Idaho to

your plate. So those types of things—and certainly there are—from the dairy industry in New York, where you want to get those products across the country. So I think, again, we've got to prioritize based on a national system, not as individual States with here's our priorities.

Ms. SHERRILL. My time has expired. Thank you very much.

Chairwoman STEVENS. Thank you. And now we'll recognize Dr. Foster for 5 minutes of questioning.

Mr. FOSTER. Well, thank you. And I'd like to just sort of continue this discussion for a moment, that what we don't have is a national metric which looks at the return on investment in a geographically neutral place, because the system that we have clearly represents the Senate more than the House, in the sense that, you know, if you look at the spending formulas, they clearly have the fingerprints of the Senate, where 17 percent of the U.S. population has a voting majority in the U.S. Senate. But that's not the subject of this hearing.

It was actually in this room, about a decade ago, that ARPA-E (Advanced Research Projects Agency-Energy) was conceived and passed, and I was wondering if any of you have input or thoughts on the usefulness of ARPA-T, this would be something dedicated for transformative technology changes. And, you know, I have spent most of my career as a high energy particle physicist, and spent a whole lot of time looking at cheap ways of tunneling, and was astounded at the number of things that have been talked about, and never tested in, for example, high-speed tunneling. You know, everything from using particle beams to blast away at the rock to just this long list of things, some of which, in terms of specific energy of excavation, look like they'd be very competitive with conventional tunnel boring machines, and yet had never been looked at. And I'm wondering, has there ever been a systematic home for this sort of stuff, and do you think there might be a need for one?

Mr. HENKEL. Congressman, I can respond from the perspective of the committee that's reviewed the Federal program. As we've reviewed the Federal program, we looked across the innovation cycle, from fundamental research all the way through deployment and evaluation. The fit for this kind of research is in the early stages, so that we can develop transformative dialogs, as well as transformative technologies. As we looked at the Federal program, we found it to be sound across the innovation cycle, but we found it to need additional investment in that early stage area.

We found that the UTC program could be an avenue for some of that big thinking, but we generally thought that the overall program, the Federal program, was in need of an infusion so that it would be able to continue the important research that it's doing in the applied arena, but grow in the area of fundamental research, and strengthen evaluation, so when those transformative technologies are thought through, and are moving through applied into deployment, the Federal program has the capability, the effectiveness, to be able to respond and deliver on those thoughts.

Mr. FOSTER. And I'd also like to have a shout out to the National Academies, that what you do on the transportation—one of the many things clogging up my inbox are the list of all the recent pub-

lications. I tend to pay most attention to human genetic engineering, or, you know, nuclear physics, but I also, from time to time, make it through at least the executive summaries of what is produced, and they really seem to be useful documents for someone who's actually, you know, boots on the ground in some state having access to that sort of high-quality summary of the state-of-the-art. So I want to just give you a shout out about that.

Let's see, Dr. Liu, you know, one of the many hats I wear around here—I'm the co-chair of the task force on artificial intelligence in Financial Services that we've set up, and, you know, obviously AI in cars is going to be something that will have to be fed with a huge amount of data, and some of this data is potentially very privacy-invading. You know, a typical self-driving car has, you know, five or six very high-quality cameras that are going out. The footage will be archived for product liability reasons, or training, in the case of near-miss accidents, and stuff like this. And I believe it won't be long before law enforcement starts subpoenaing that very interesting footage, so that when there's a drive-by shooting in some area, you'll electronically subpoena all that. Are the discussions that have to happen around that sort of application happening? Or are you going to be in a situation where you're maybe technologically ready to deploy a lot of this, you know, self-driving vehicles, but you don't have the legal certainty regarding privacy?

Dr. LIU. Congressman, you reached a very, very important issue, and that's the issue—that's—I also mentioned that, in terms of the research we will need to do. And—so the deployment of connected automated vehicles is not only an engineering product. It's actually much more than that. It involves both—not only social, legal, and—but also political aspects of things. So cybersecurity, as well as privacy protection, I think it's very, very important, and in our UTC—it's part of our UTC's research portfolio to look into those. We have research projects to look into those also.

Mr. FOSTER. And the discussions involving privacy, where are those happening? Because they have to have many people in the room, not just, you know, automotive engineers.

Dr. LIU. Right. So—and that's what I'm saying. This—the UTC also have—I think have a mechanism that we can bring together the expert from different aspects, and we have a technology advisory committee which we can bring together all these people from not only just engineers, but also the other experts together to look into these issues. So privacy issues obviously is very, very important for us.

Mr. FOSTER. Thank you. I'm over time here, and yield back.

Chairwoman STEVENS. Well, before we bring this hearing to a close, we, obviously, want to thank our witnesses again. This has been a great conversation, great contribution to the work that we're going to be doing, particularly around reauthorizing the *FAST Act*, and chartering a vision for the Nation's surface transportation research agenda. It's obvious that the built environment, the veins of our commercial activity, and what our highways represent for our Nation, a land of sea to shining sea, and all of its complexities, needs a long-term strategic vision, needs the experts at the table.

And it also plays an interesting role for the Federal Government to partner in a very concerted and catalytic way to bring research-

ers, State actors, municipal actors, and private industry, together to come up with solutions to be the best, to be the leader in the free world for this type of transportation. And while we're certainly inspired by the environmental opportunities that rail provides, and it's one of our other components of the built environment, we can still achieve environmental sustainability measures through our highways, vis-a-vis our highways, and what that means for everyday consumers. And as we continue to inch toward the plight of zero accidents, and zero emissions, and a cleaner, fairer, and more complete vision of our Nation's transportation sector, and the role, the critical role, that research will forever play in achieving those goals.

So the record is going to remain open for the next 2 weeks for additional statements from the Members, and for any additional questions the Committee may ask of its witnesses. And, at this time, our incredible witnesses are excused, and the hearing is now adjourned.

[Whereupon, at 4:51 p.m., the Subcommittee was adjourned.]

Appendix I

Additional Material for the Record

STATEMENT SUBMITTED BY REPRESENTATIVE HALEY STEVENS

ITS AMERICA

July 11, 2019

The Honorable Haley Stevens
Chairwoman
Subcommittee on Research and Technology
Committee on Science, Space, and Technology
United States House of Representatives
Washington, DC 20515

The Honorable Jim Baird
Ranking Member
Subcommittee on Research and Technology
Committee on Science, Space, and Technology
United States House of Representatives
Washington, DC 20515

Dear Chairwoman Stevens and Ranking Member Baird:

In anticipation of the Subcommittee on Research and Technology upcoming hearing entitled "Bumper to Bumper: The Need for a National Surface Transportation Research Agenda," the Intelligent Transportation Society of America (ITS America) writes to underscore our support for a Fixing America's Surface Transportation (FAST) Act reauthorization that recognizes the added value of integrating technology into transportation infrastructure and services and provides funding for research and the rapid deployment of intelligent transportation technologies quickly and uniformly to transportation agencies and providers across the entire country.

Over the years since the FAST Act was signed into law, automated and connected vehicle technologies have advanced, the collection and use of big data has become an increasingly valuable tool for decision makers, electrification of vehicles of every type from human scale to large-scale continues, and Mobility on Demand services are transforming how we get around. These technologies allow additional freedom of movement for those who have limited mobility access, such as people with disabilities, older adults, and those living in transit deserts. Technology advancements will also help begin to reduce the epidemic of fatalities on our roadways.

Given the title and focus of this hearing, this letter summarizes ITS America's FAST Act reauthorization platform: Moving People, Data, and Freight: Safer. Greener. Smarter—with a focus on policy and recommendations under the jurisdiction of the Committee on Science, Space, and Technology. Moving People, Data, and Freight bridges new and existing infrastructure technologies and new modes of mobility that we see across the country with the utmost importance of investments to bring our infrastructure to a state of good repair and integrate technology to maximize efficiencies and safety and secure the United States' global leadership in the development and deployment of advanced transportation technologies. ITS America's Moving People, Data, and Freight: Safer. Greener. Smarter. policy and recommendations include the following:

INCREASE INVESTMENT IN RESEARCH AND DEPLOYMENT OF INTELLIGENT TRANSPORTATION TECHNOLOGIES.

ITS America supports increased funding for research, development, and demonstration of intelligent transportation systems technology. ITS America strongly supports the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) program. The association supports increasing funding and federal share to 80%. It recommends increasing the federal share to 100% for safety critical connected vehicle technologies including Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), and Vehicle-to-Pedestrian (V2P) under ATCMTD.

The association also supports policy that makes V2P technologies an eligible activity under ATCMTD. Pedestrian deaths increased by an estimated 4 percent and "pedalcyclist" deaths increased by an estimated 10 percent in 2018, according to NHTSA's preliminary statistics. V2X will enable deployment of safety

solutions to protect these vulnerable users of the system. By allowing vehicles to communicate with users through sensors or vehicle-to-device communication, we can significantly reduce the number of people killed on our roadways. V2P encompasses a broad set of road users - people walking, children being pushed in strollers, people using wheelchairs or other mobility devices, passengers embarking and disembarking buses and trains, and people riding bicycles and scooters.

ITS America recommends that the FAST Act reauthorization authorize and dedicate separate funding for ATCMTD. Under the FAST Act, the ATCMTD program has been funded through a set-aside from the Highway Research and Development, Technology and Innovation Deployment, and Intelligent Transportation System Research programs and has resulted in a reduction of transportation research and development that has historically propelled United States leadership in areas such as connected and automated vehicle development as well as the emerging area of artificial intelligence in mobility management.

PRIORITIZE THE 5.9 GHZ SPECTRUM FOR VEHICLE-TO-EVERYTHING (V2X) PUBLIC SAFETY TRANSPORTATION COMMUNICATIONS

ITS America supports policy that makes clear the 5.9 GHz band is prioritized for existing, new, and developing vehicle-to-everything (V2X) technologies that send hazard alerts to infrastructure, motorists, pedestrians, and other transportation system users and hold the promise to enhance automated driving systems. ITS America supports a policy that ensures all three phases of testing for the 5.9 GHz band are complete before the FCC rules on whether the spectrum can be shared between V2X operations and unlicensed devices like WiFi.

The U.S. Department of Transportation is working with industry, safety, and public sector stakeholders to develop and evaluate cooperative technologies, equipment, and applications known as Connected Vehicle (CV) technologies that operate in the 5.9 GHz band, inclusive of V2V, V2I, and V2P – collectively referred to as Vehicle-to-Everything (V2X). This includes all V2X technologies – Dedicated Short Range Communications (DSRC) as well as Cellular vehicle-to-everything (C-V2X) – because the band can be configured to enable real-time crash-avoidance alerts and warnings—offering a significant opportunity to achieve a transformation in transportation safety.

Cable companies and their supporters are seeking additional spectrum for enhanced WiFi experiences and are aggressively pressuring the Federal Communications Commission (FCC) to force public safety transportation communications operating in the 5.9 GHz band to share that spectrum with unlicensed consumer broadband devices. Speed matters when safety information is involved. Sharing the band could compromise the speed and put lives at risk. What if a driver knew, in fractions of a second, that an airbag deployed in a car in front of them? Alternatively, that the car in front, around the next curve, was sliding on black ice? Or a person is walking just around the next corner? Thanks to V2X, that driver would react – and avoid a crash. Deploying V2X that allow cars, trucks, bicycles, motorcycles, streetlights and other infrastructure to talk to each other will ensure more people travel safely. Safety is the top priority of the nation's transportation system.

SAFEGUARD TRANSPORTATION INFRASTRUCTURE FROM CYBERSECURITY THREATS

ITS America supports policy that would provide states and localities funding and technical assistance under the ATCMTD to safeguard critical transportation systems that are more reliant than ever on connectivity to communicate and exchange data from cybersecurity threats. As vehicles and infrastructure

become more connected, our nation's transportation system faces increasing cybersecurity risks. Given the ability to cause loss of life and inflict significant economic damage in a highly visible manner, cybersecurity attacks directed at those producing or operating technologies travelling over or connected to U.S. roadways will intensify.

STRENGTHEN THE UNIVERSITY TRANSPORTATION CENTERS PROGRAM

ITS America supports reforms in the University Transportation Centers program that directs grants to universities with research and technical expertise; encourages leading edge as well as near-term practical applied research (reduce the time period from research concept to completion); encourages broader inclusion of ITS-related curriculum, degrees, and professional development programs for current and future workforce; and increases opportunities for private sector funding contributions.

Just as transportation infrastructure was critical to the development of our economy in the 20th century, maintenance of infrastructure, research, and deployment of intelligent mobility and smart infrastructure will be critical for our global competitiveness in this century. Advances in robotics, artificial intelligence, and wireless communications will define the way people, goods, services, and information move in the 21st century - and most importantly, finally help begin to reduce the fatalities on our roadways. With vision and leadership, the Committee on Science, Space, and Technology increased investment in transportation research in the FAST Act. Only with investment certainty will the nation finally see and benefit from the research and the large-scale transformational deployments of intelligent transportation technologies.

ITS America stands ready to continue to work with the Subcommittee on Research and Technology of the Committee on Science, Space, and Technology on a reauthorization that increases research in intelligent transportation technologies that advance transportation safety and mobility, reduce congestion, improve air quality, and enhance American productivity. ITS America's full FAST Act reauthorization platform: Moving People, Data, and Freight: Safer. Greener. Smarter. is available at www.itsa.org/policy-infrastructure.

Sincerely,

Shailen P. Bhatt
President and CEO
Intelligent Transportation Society of America

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